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ABSTRACT

Twenty-two projects are described in this booklet. Materials necessary for construction can be obtained for little cost or as salvaged parts. Equipment produced by these projects can be used in the collection and study of plants and animals and in the study of environmental quality parameters such as air quality and soil conditions. Construction of some of the devices may draw on the resources of various secondary school disciplines. (RE)

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STUDENT-MADE ENVIRONMENTAL STUDIES EQUIP VOLUME II

U.S. DEPARTMENT OF HEALTH
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Manchester, New Hampshire 03102

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Cover Credits —

#1 — A feathered friend leaving the dropping perch bird feeder. Picture by Steve Hadlock

#2 — A junior high student starting construction on a terrarium. Picture by Barry Wolper

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STUDENT-MADE ENVIRONMENTAL STUDIES EQUIPMENT

INTRODUCTION

For some time the editors of this publication have been acutely aware of the need for environmental testing equipment at the high school and the junior high school level. We conducted a survey during the year 1971 to determine the need of such testing equipment. This activity began when the editors of this guide were watching students from Manchester West High School present their well-known slide show on environmental pollution.

The slide show was one of three produced by the teachers and students of West High School. Throughout the discussion, scenes of students using Secchi disks, Dissolved Oxygen samplers, Peterson Dredges, and other environmental testing and sampling equipment, were depicted. At the conclusion of the show, a question and answer period, as well as a rap session, were customary. It was during these sessions that we became aware that certain questions were asked more than others: "What is a Secchi disk? What is it used for? What is a D.O. bottle? What is a B O.D. apparatus? What is it used for?" These and many other questions were asked. The schools did not have the use of any environmental testing equipment.

With a few pieces of homemade equipment available, it was decided to take a good look at them with the idea of making a few models to be shown along with the slide show presentation. These early pieces of equipment were very crude, but with some effort and time, a few members of the high school Ecology classes were able to produce a Secchi disk and a Plankton net. These products were excellent — in fact, as good as the commercial variety.

Some of the teachers tried their own hand on the needed items and one teacher offered extra credit to a class of low ability students for each item produced. It caught on — some had low ability in reading and writing, but not in manufacturing or in design and dexterity. This equipment has been demonstrated all over New England. Teachers were asking for the plans, blue prints, or a sample to go by.

With U.S. Office of Education (Environmental Education Office) support, we developed a joint Science and Industrial Arts venture and have been able to develop additional protypes. High schools were buzzing with student-made equipment projects, and it wasn't long before the Home Economics Department was included with Science and Industrial Arts making plankton nets and other equipment. The Art Department followed with sketches of equipment use as was the Drafting Department, Carpenter Shop, Sheetmetal and Electronics — all were turning out fine pieces of equipment with plans for better ones.

As our funds were limited in this area, we emphasized the importance of re-cycled materials to our students. In fact, a student could obtain a better grade from an item built from these used materials as opposed to one where they were purchased or partly purchased. Junk yards, industrial waste piles, and remnants from many crafts were sort out by the students and recut and designed to produce the objects presented in this publication. For example: to make a Plankton net, an all metal coat hanger is needed. This is bent into a circle (as described in this booklet) and wound with fine copper wire (scrounged from an electronics industry). This was soldered to keep it from pulling apart. A propane torch, or a gas burner from the science lab, or more refined equipment in the Industrial Arts Department may be used to do this job. The cloth was usually the leg from a panty hose (a run in one leg means it is no good to sister or mother, but the leg without the run is just great for the Home Economics Department to sew on the coat hanger hoop). Used parachutes are excellent material and many nets can be made from one of these. Salvaged elastics from used clothes were also sewed into the tapered end by the Home Economics Department into which a pill bottle was held securely. Salvaged line preferably one quarter inch, completes this item. Quite frequently, solder is the only cost. As our students presented their slide shows and their demonstration of homemade equipment, we now started leaving a few samples at each school we visited. We had also, during this time, produced a draft of a home-made equipment guide which we also left behind. To some schools without a budget for testing equipment, it was a wonderful beginning to have the use of these student-made devices. It gave them new dimentions, and environmental studies in many schools started from these humble gifts.

It is hoped that all who receive a copy of this publication will find it of value to them in their own school programs. It would be a great injustice to close this introduction, without giving credit to the teachers who gave so much of their time in helping their students design the tools found in this pamphlet. It

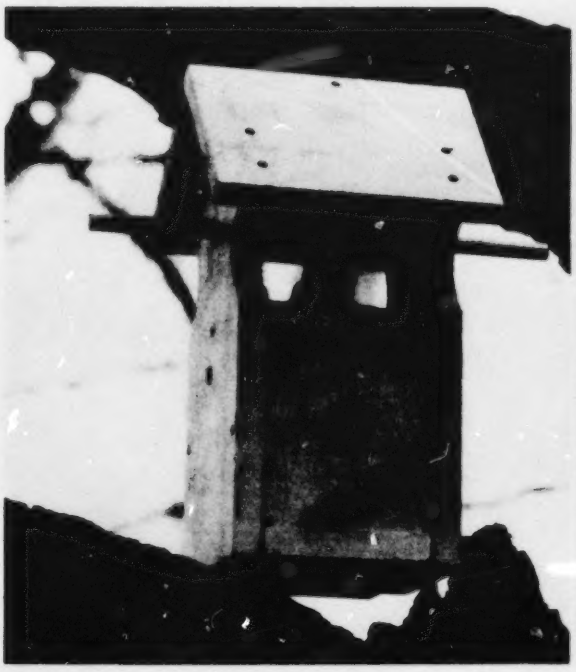
would be impossible, however, to list them all, as there were so many of them from all over New England and other parts of the country. However, a few individuals stand out as being most generous and are worthy of individual mention. Therefore, it is with a feeling of greatest appreciation the editors list the teachers below, who, along with their students, made this all possible:

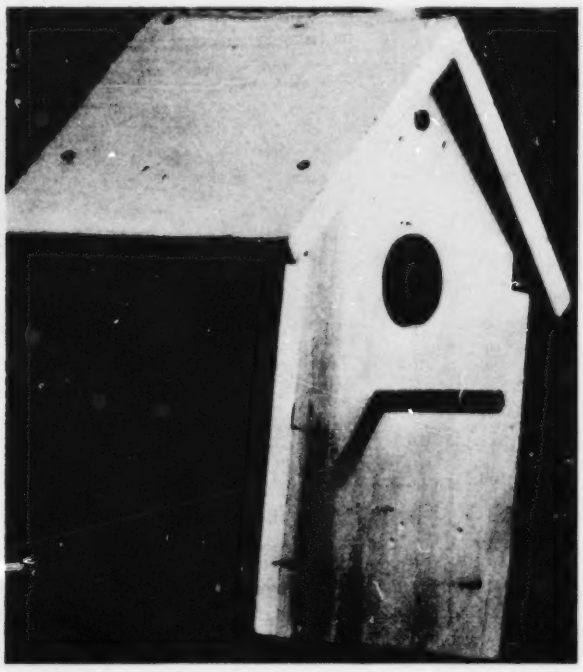
1. **Bishop, Mrs. Doris,** West High School for her work on the Plankton nets, plant press straps, and all the sewing.
2. **Bowers, John,** for his drafting and expert advice.
3. **Fortin, Sheila,** for her art work and drafting.
4. **Hadlock, Steven,** St. Anselm's College student, for his Plankton nets, excellent photography, and lay-out work on this publication.
5. **Hall, Jon,** Pinkerton Academy, Derry, N. H., for new ideas and encouragement.
6. **Horner, Herbert,** Parkside Jr. High School, for his tuna stove, Biltmore sticks and calipers, plus much more.
7. **Jones, George,** Memorial High School, for his Hester-dendy sampler, bird houses, and many other items.
8. **Jones, Mrs. Kathleen E.,** Maynard School, for her insect nets, dissolved oxygen bottles, and other equipment.
9. **Klaxton, Richard,** West High School, for his vasculum and D.O. bottle plus other equipment.
10. **Tartsa, Alex,** West High School, for his modification of the Peterson dredge, core sampler, and other items.
11. To all of the Industrial Arts Teachers and Home Economics Teachers, along with the Science Teachers who gave of their time to make this possible.

The editors feel special thanks are in order for Herbert Horner, Alex Tartsa, Richard Klaxton, and George Jones who perhaps donated more of their time than others in this program.

The Editors: James W. Morrison, St. Anselm's College
James A. Hall, West High School

December 31, 1975

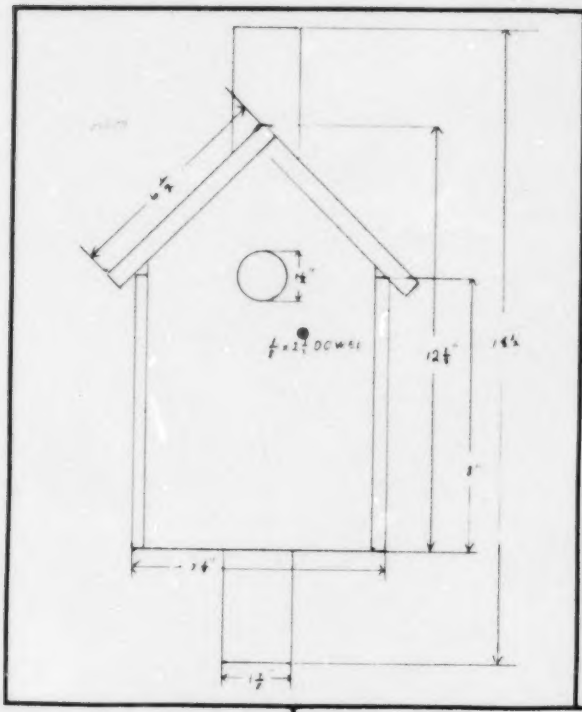


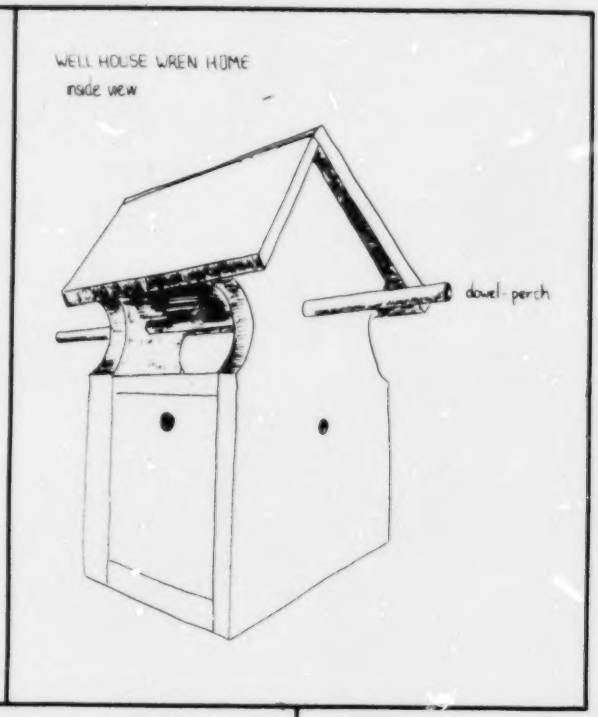


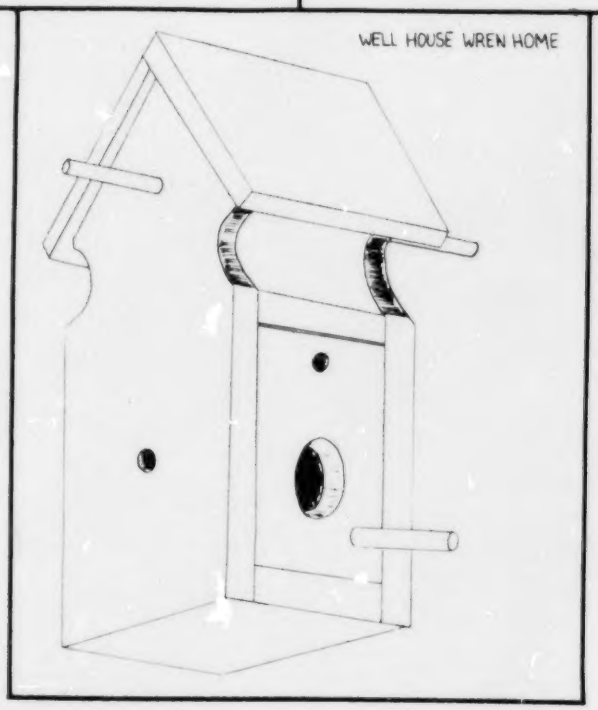
WRENS HOUSES

Two versions of the wrens house can be constructed. The simple version follows traditional bird house design and can be constructed with scrap lumber in a short time.

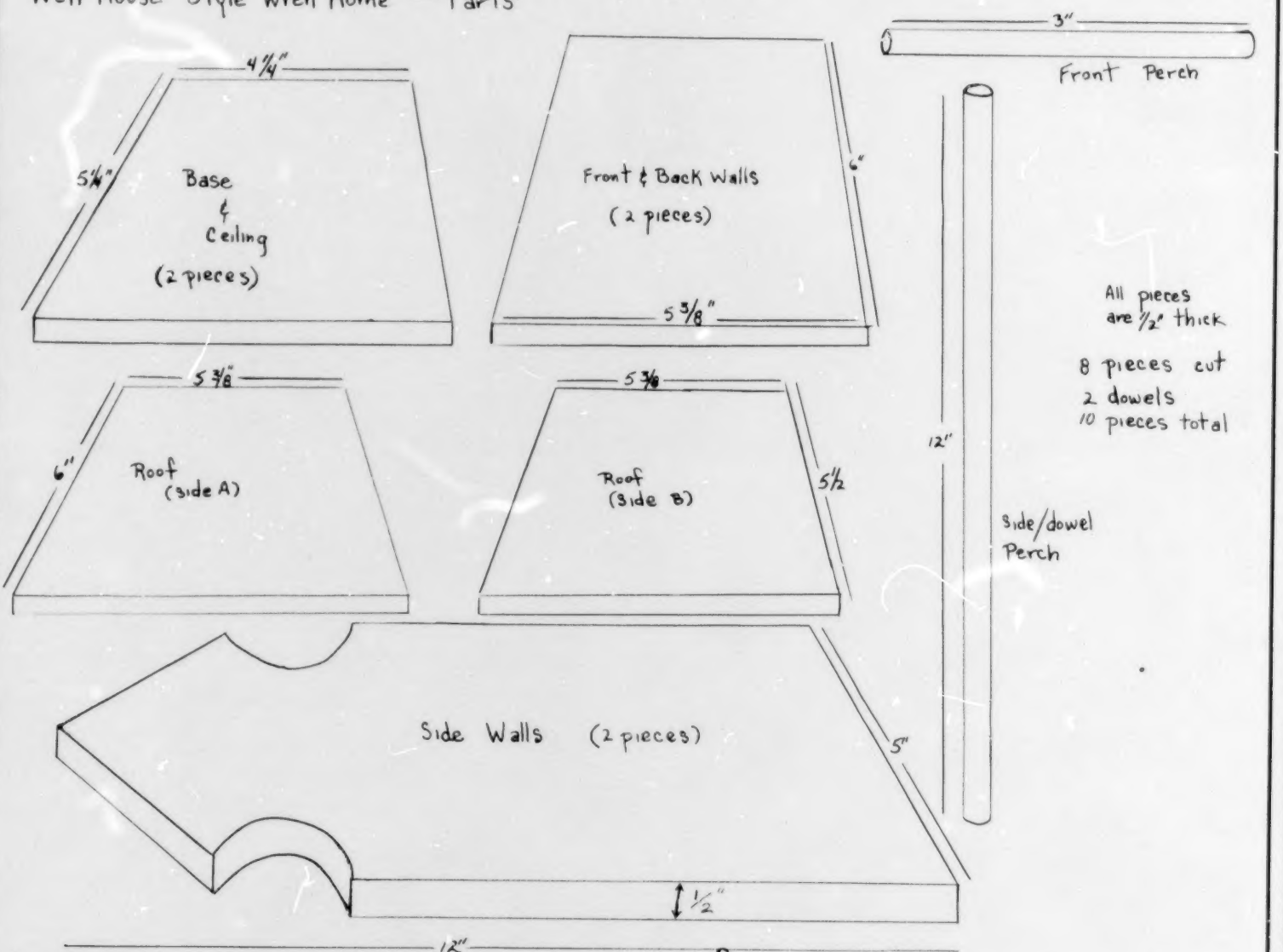
The well house design provides a decorative touch to one's yard, while at the same time providing a habitat for local wrens. The curved indentations are cut with a sabre or coping saw. Several perches are provided for, to allow observation of the wren families.







Well-House Style Wren Home — Parts

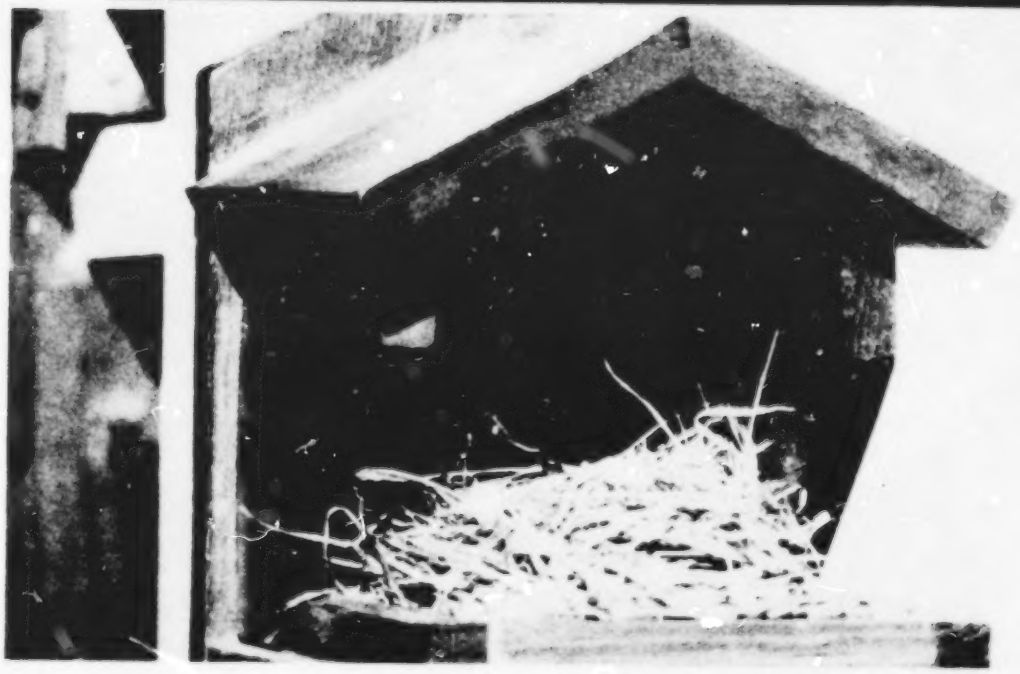


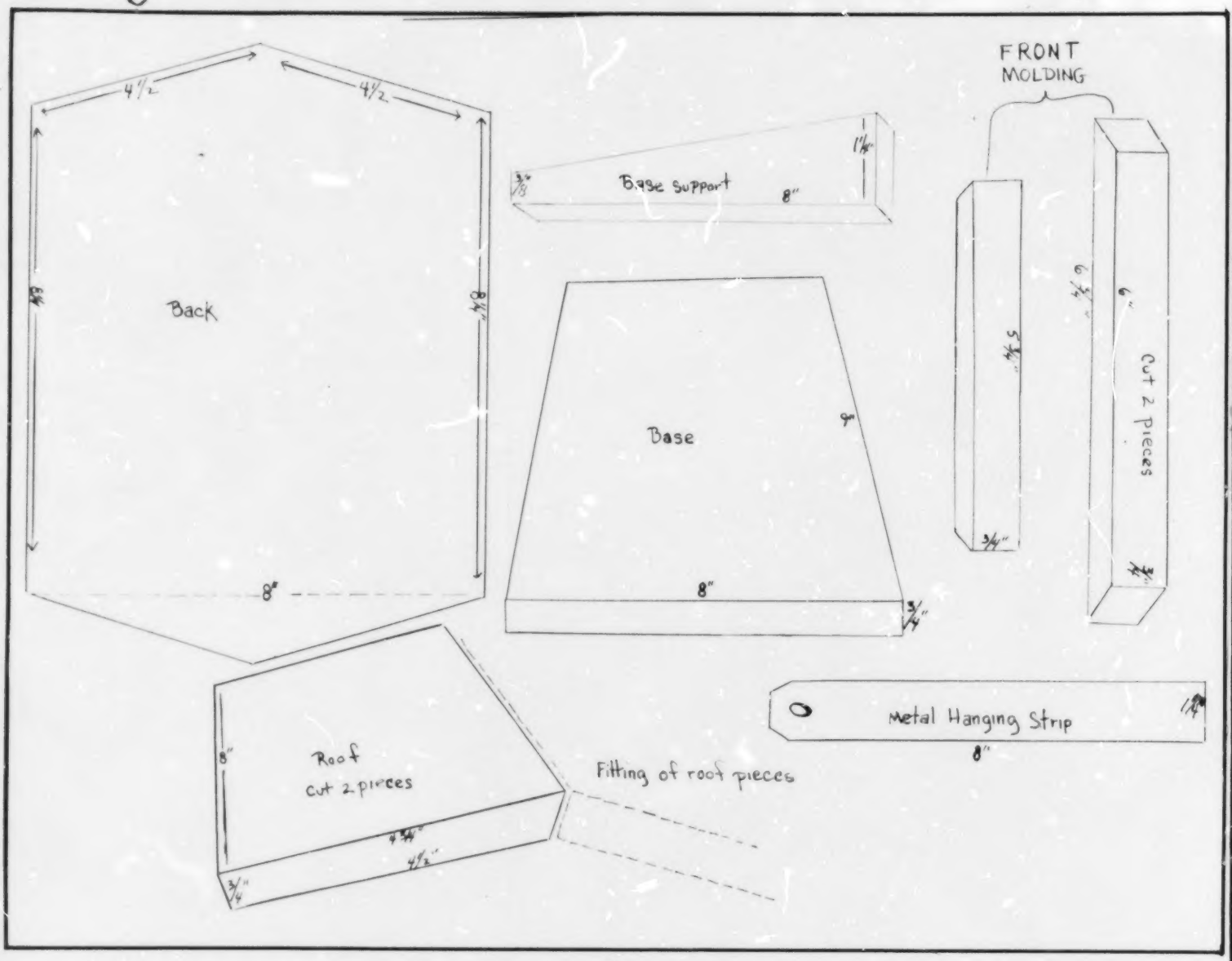
ROBIN'S HOUSE

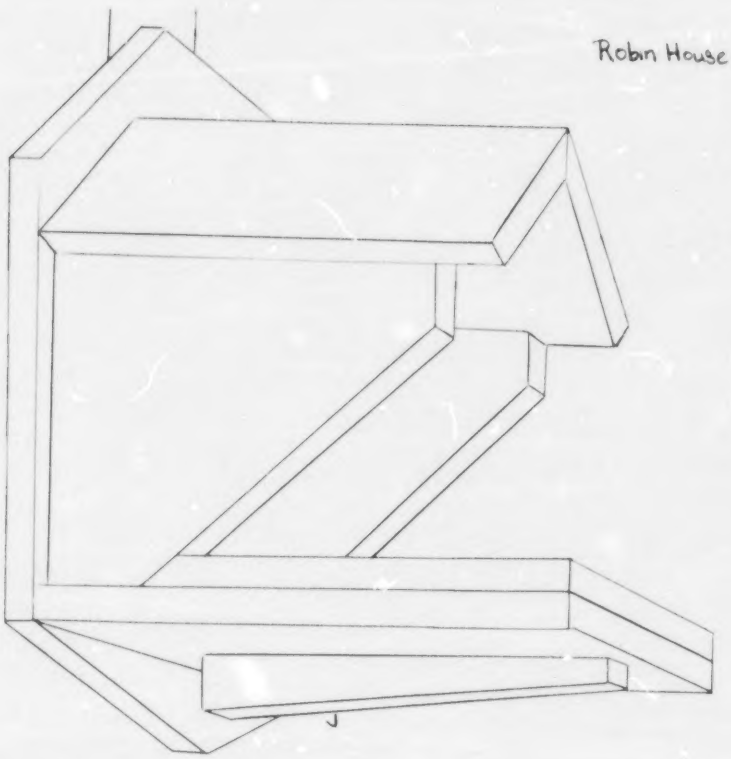
The robin, by nature, is a shy, cautious bird. It will readily sit huddled on a branch in the rain, rather than seek shelter in an enclosed bird house.

The robin's house design is so structured as to provide some shelter for these birds while allowing them a large, unobstructed field of view. Constructed of ¾" thick lumber, the house features the equivalent of 2½ open sides while offering protection from the rain.

Before emplying the house outside, check the prevailing wind patterns for your area and orientate the house away from the prevailing wind. This will ensure maximum protection from the elements. The robins readily take to the house and will locate their nests there.

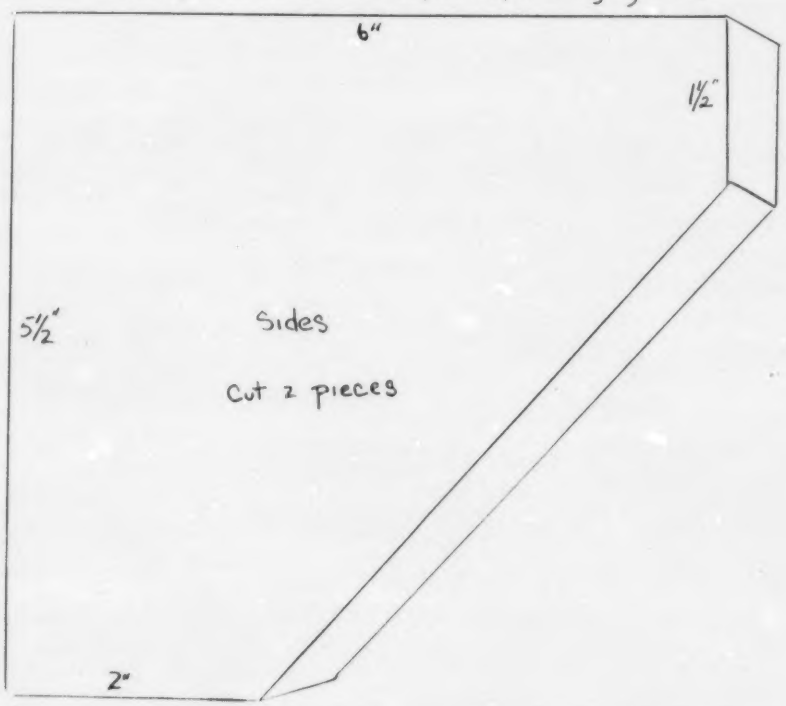



4½
4½
Back
8"
8"
8"
Base support
8"
Base
8"
9"
3/4"
FRONT
MOLDING
5¾"
3/4"
6¾"
6"
Cut 2 pieces
3/4"
Metal Hanging Strip
8"
8"
Roof
cut 2 pieces
4½"
4½"
3/4"
Fitting of root pieces



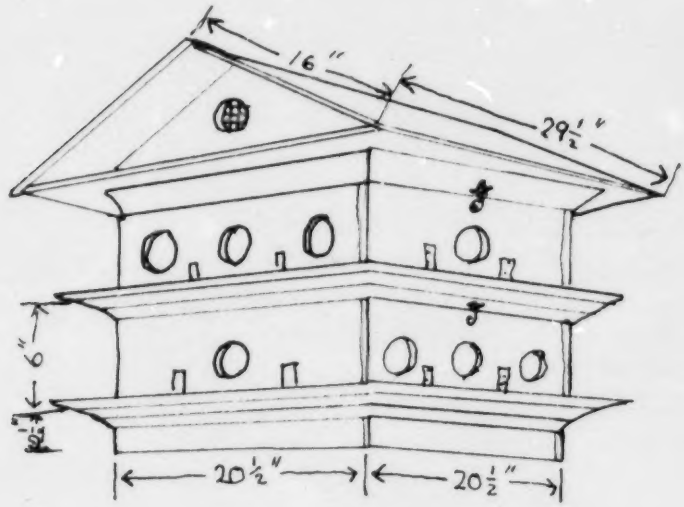
Robin House: Components

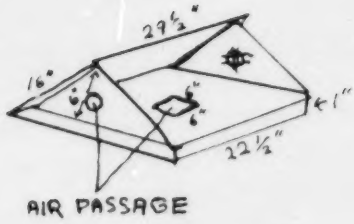
All parts are ¾" thick, except hanging strip

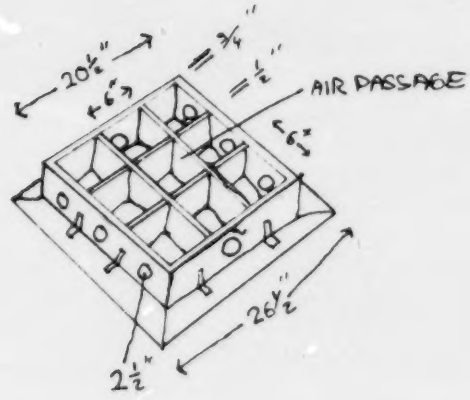


PURPLE MARTIN CONDOMINIUM

The purple martin is a communal bird that shuns individual housing. Its living requirements are such that an "apartment house" is a necessary design to support martins in any one area. Designed along a two-story layout, the martin's house will provide living space for eight parts of martins plus babies, per floor. The central shaft allows ventilation through all individual units. The two floors are connected with hooks and eyes, to allow easy take-down and cleaning.







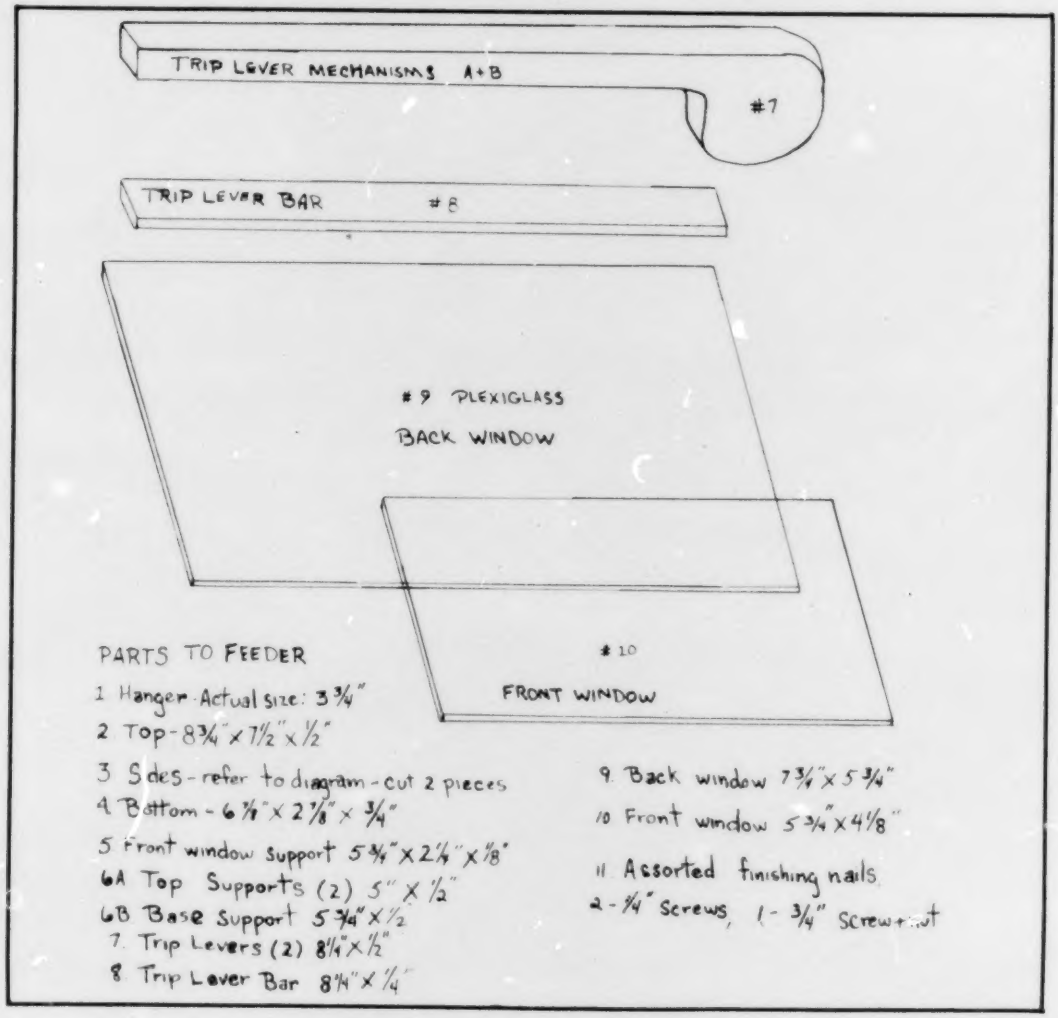
WEIGHTED PERCH FEEDER

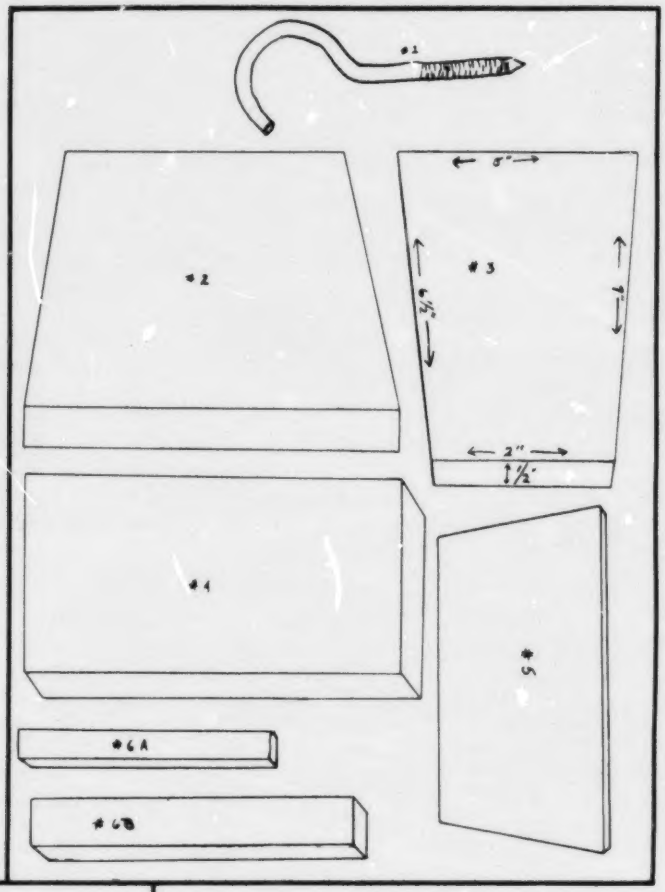
The counter-balanced perch type of feeder is designed to give an advantage to the smaller birds found around one's yard. Often, with stationary feeders, blue jays, grackles and other large birds will dominate the scene, depriving sparrows and other smaller birds of seed, suet, bread, etc.

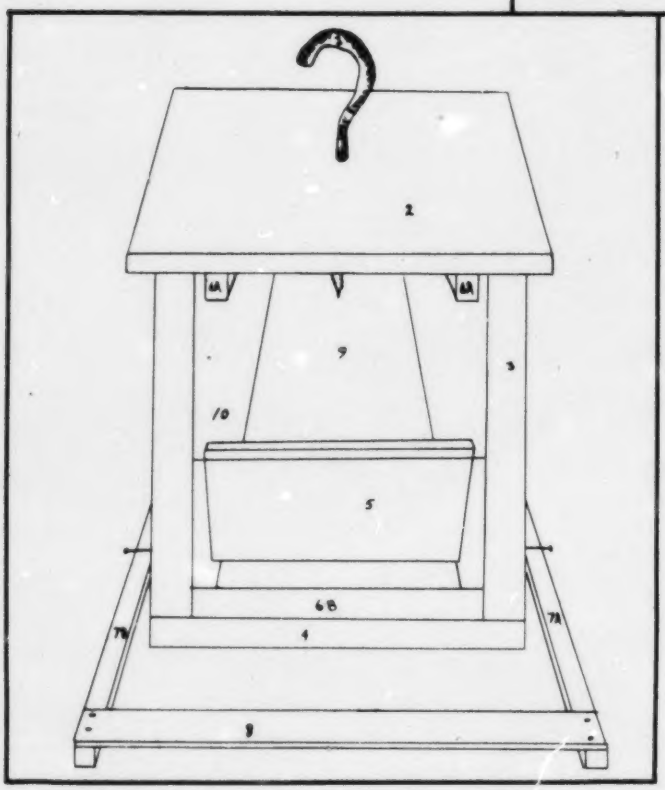
Utilizing a bolt with machine nuts screwed on to it, inserted in the rear balance arm of the perch, the feeder can be adjusted to accommodate various sizes of birds according to their respective weights. The smaller birds will lightly land on the perch and eat from the self-supplying gravity-feed seed trough. The larger birds will land on the perch, and since they will be heavier than the counterweights, the perch will pivot down, "dumping" them off.

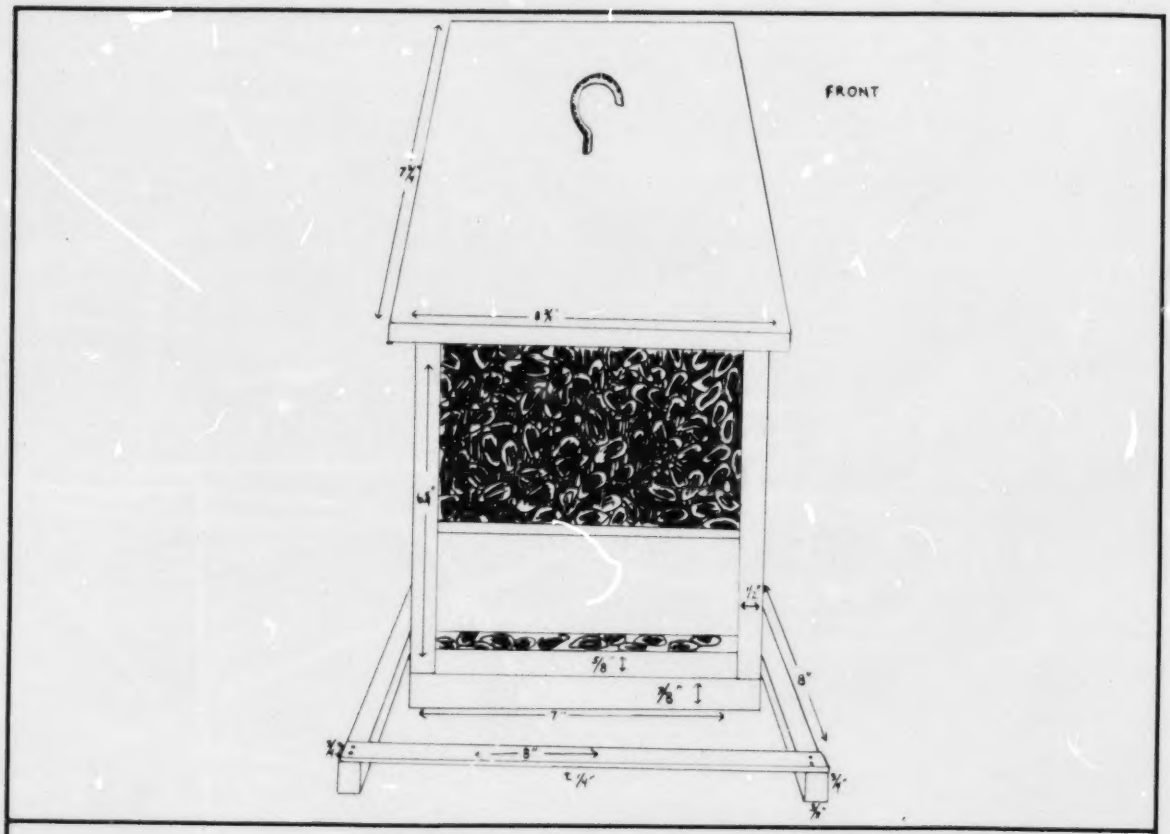
The feeder is constructed from ½" and ¼" thick wood. The front and back plates are composed of scrap plexiglass sheets. The front window support (piece #5) is inserted at an angle to the front window, and serves as a guide for the seed to slide down into the trough when empty. A plug may be constructed, to fill the seed chamber from the top. The perch trip levers (piece #7) are connected to the feeder by two ¼" wood screws which act as pivots. The screw holes may be enlarged slightly to ensure freedom of pivot when in use.

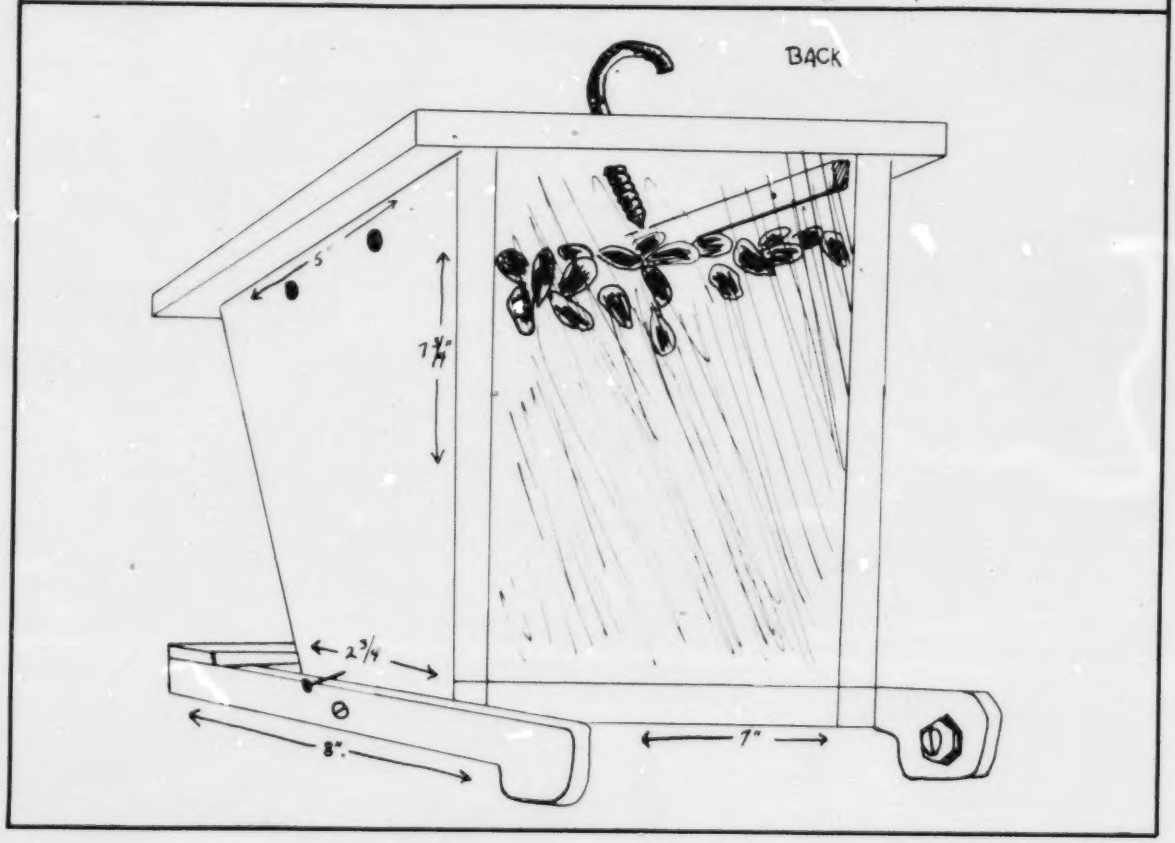
The counter-balance used in the prototype test consisted of a ¾" screw with a nut attached. This seemed adequate to allow sparrows to feed while discouraging blue jays. A few days of observation with various weights will determine the best combination of weights for individual needs.

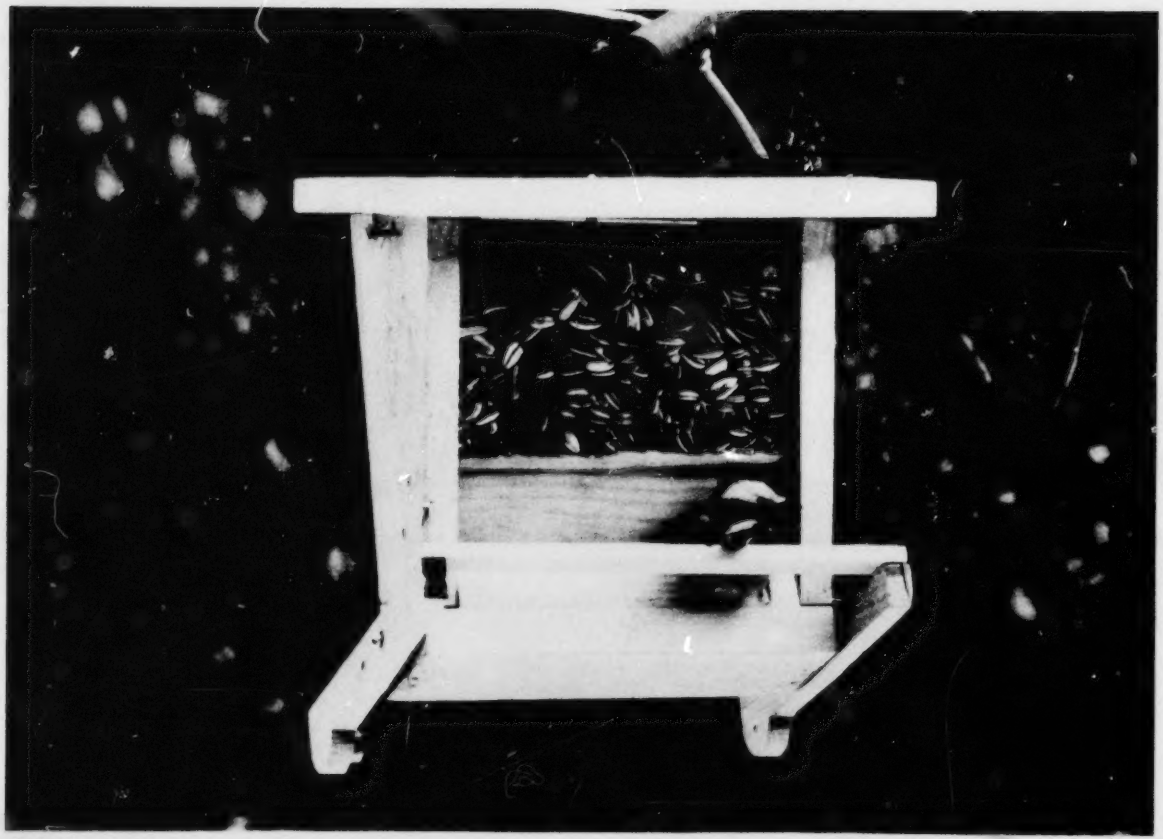

TRIP LEVER MECHANISMS A+B
#7
TRIP LEVER BAR #8
#9 PLEXIGLASS
BACK WINDOW
#10
FRONT WINDOW
PARTS TO FEEDER
1 Hanger-Actual size: 3¾"
2 Top-8¾" x 7½" x ½"
3 Sides-refer to diagram-cut 2 pieces
4 Bottom-6⅛" x 2⅞" x ¾"
5 Front window support 5¾" x 2¼" x ⅛"
6A Top Supports (2) 5" x ½"
6B Base Support 5¾" x ½
7 Trip Levers (2) 8¼" x ½"
8 Trip Lever Bar 8¼" x ¼"
9 Back window 7¾" x 5¾"
10 Front window 5¾" x 4⅛"
11 Assorted finishing nails
2-¾" Screws, 1-¾" Screw+nut


#1
#2
#3
5"
3½"
1"
2"
1½"
#4
#5
#6A
#6B


2
9
3
10
5
6B
7A
4
8


FRONT
8"
4"
7/8"
7/8"
7"
8"
8"
2 1/4"
3/4"
1/2"


BACK
5"
7 1/4"
2 3/4
8"
7"



HANGING HUB-CAP FEEDER

Since discarded hub caps are almost always readily available, they can be used as a fairly good feeder with a minimum of work.

Punch three or four holes around the perimeter of the cap at 120° or 90° apart respectively. Run rope or wire through these holes and secure the feeder to an overhanging branch or pole. It is often advantageous to put one feeder near the house for those birds used to people, and one at the far end of the yard or lot, in a fairly secluded section for the more timid species. These also make excellent ground-level feeders for those species who prefer feeding on the ground.

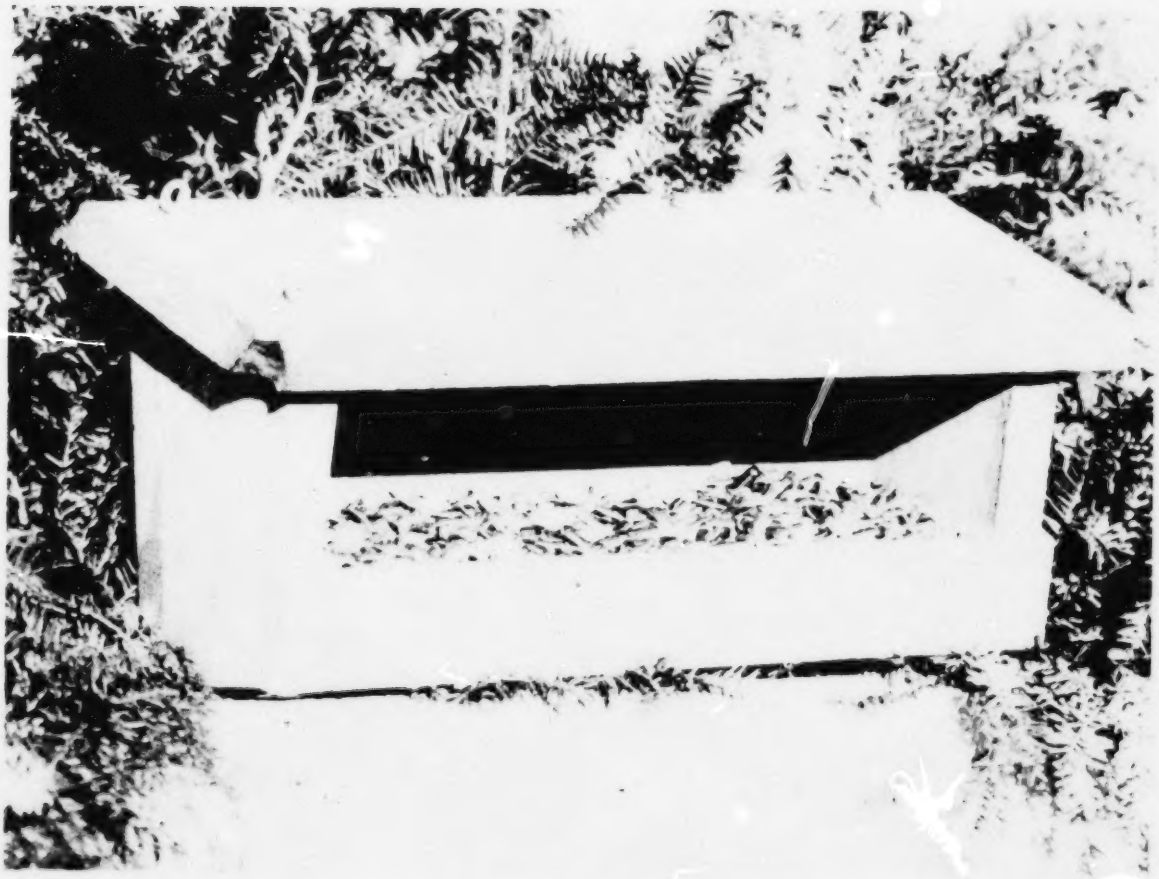
It cannot be emphasized enough that if a feeding program is begun in autumn or early winter, it must be continued into late spring. The birds in the area will come to depend on the feeder as a major source of food. IF FEEDING IS DISCONTINUED, THE BIRDS WILL DIE OF STARVATION. *YOU* ARE THEIR LIFELINE.

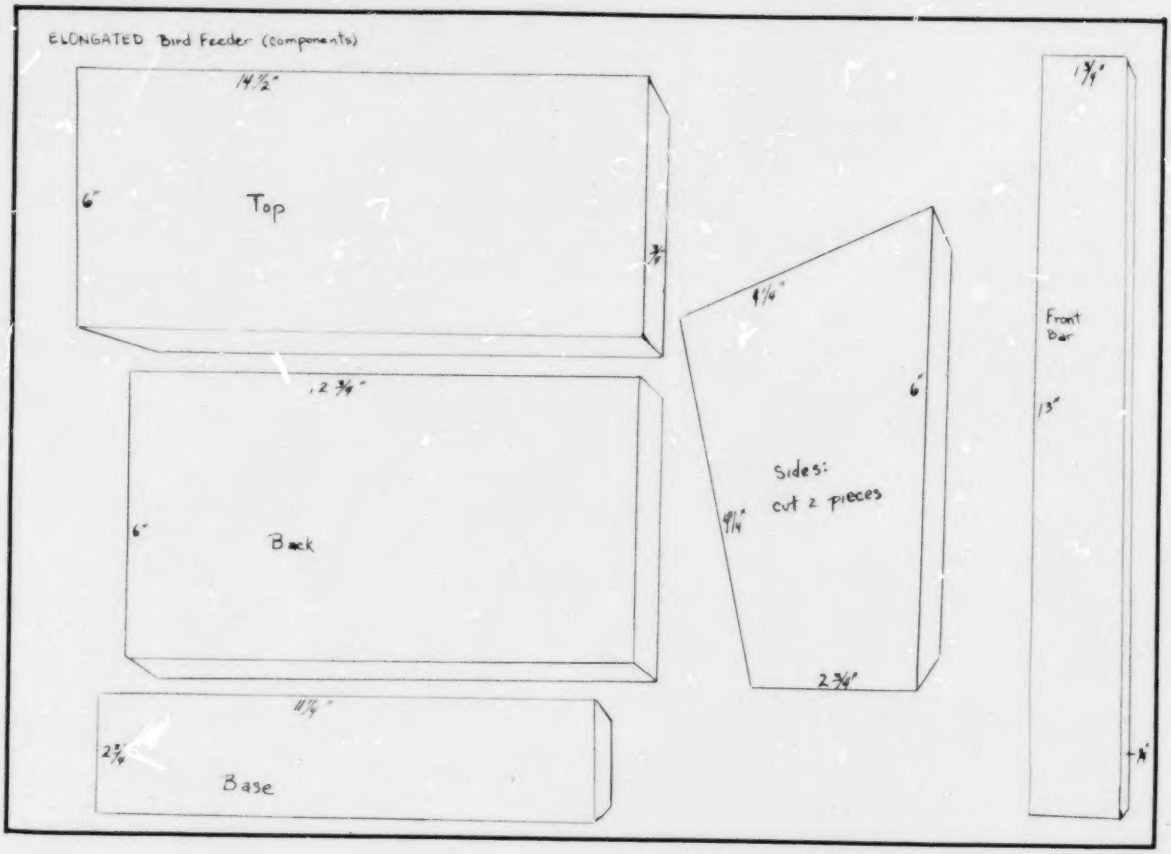
ELONGATED BIRD FEEDER

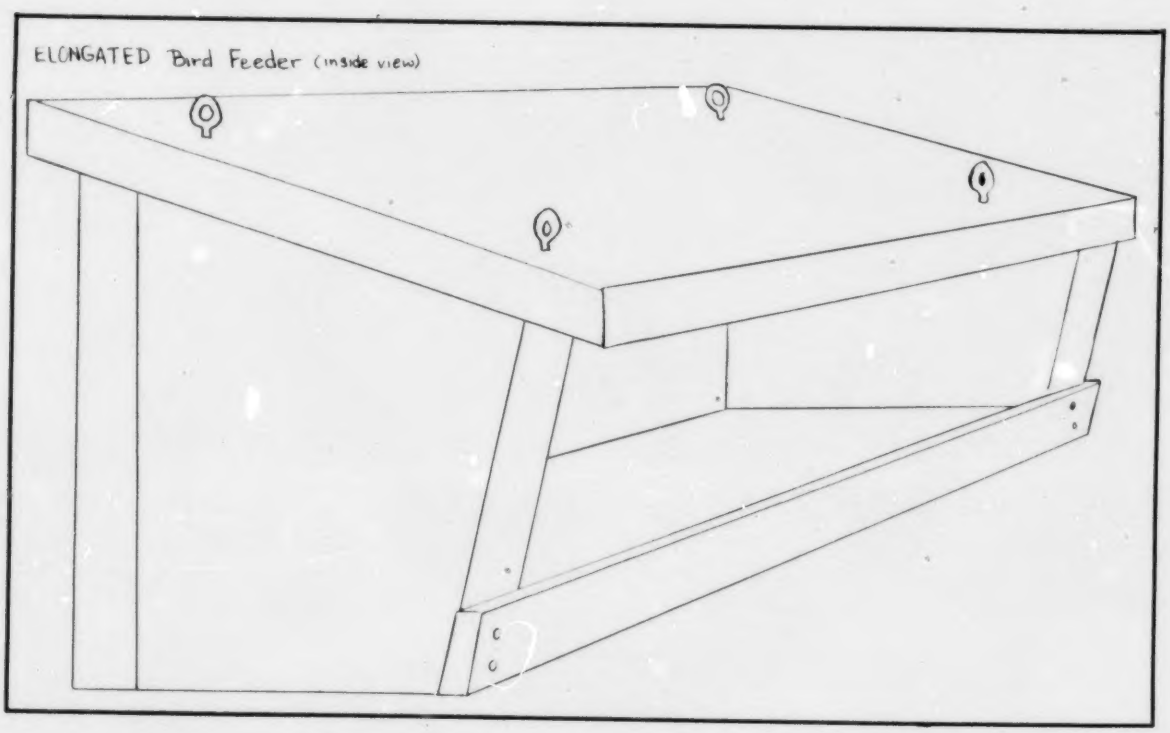
This is a versatile feeder design that will accommodate almost all species of birds that frequent home feeders.

It is constructed of ¾" thick lumber scraps with a ¼" thick front bar. The 1¾" diameter of the front bar allows approximately one pound of sunflower seeds to be contained inside the feeder at one time.

The feeder may be suspended from an overhang or tree branch by means of eye hooks inserted in the roof. It is also interesting placed in a window box, allowing close observations of the birds' feeding behavior.




ELONGATED Bird Feeder (components)
14½"
6"
Top
¾"
12¾"
6"
Back
11¼"
2¾"
Base
9¼"
6"
Sides:
cut 2 pieces
9¼"
2¾"
1¾"
Front
Bar
13"
¾"


ELONGATED Bird Feeder (inside view)

NEST VIEWING MIRROR

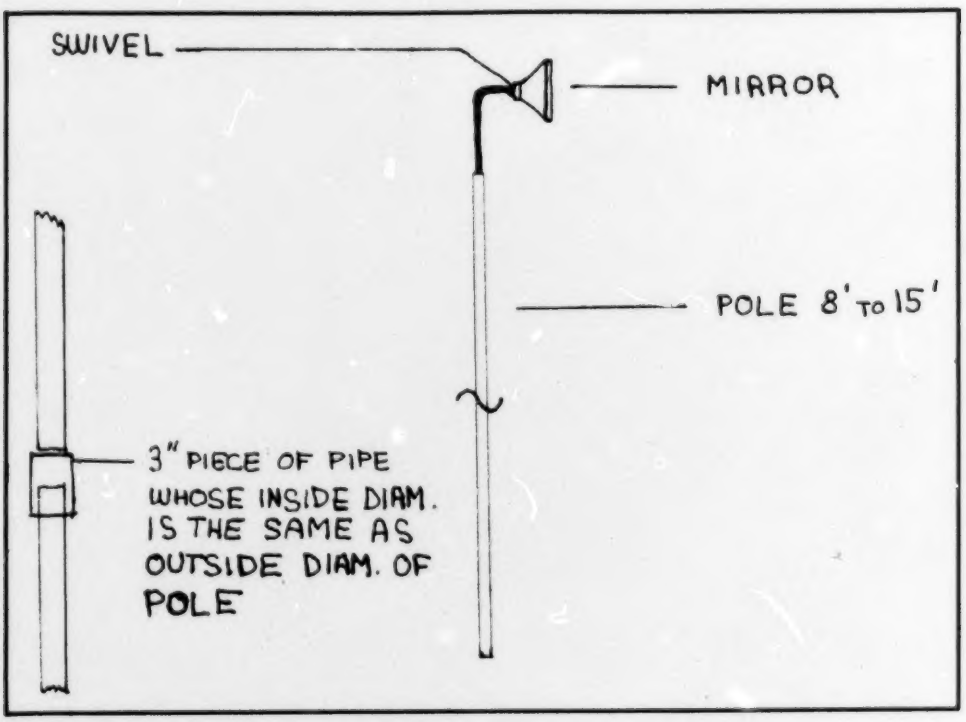
This device is a mirror from a junked truck or car, mounted on a long pole, sapling, or light weight aluminum pipes. The mirror must be one with the ball and socket so it can be bent to the angle necessary to reflect the nest from a distance. Pipe in sections are excellent as joints may be added as needed, depending upon the height of the tree. Truck mirrors are larger and most preferred. Pipe joints may be the screw type, or those that fit into each other.

MATERIALS

1 swivel remote side auto mirror — can be obtained from an old auto

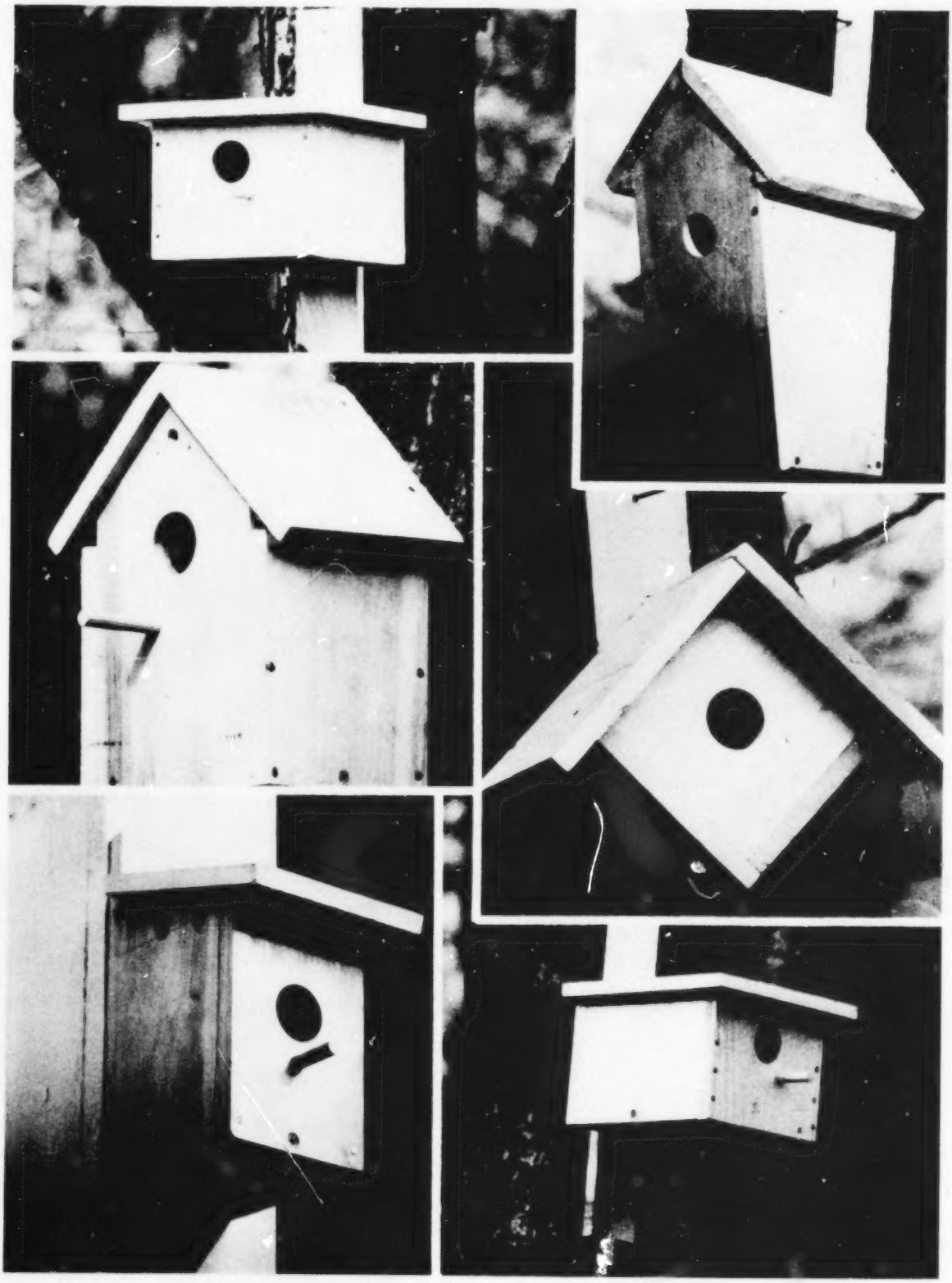
1 swivel attachment

1 pole, plastic pipe, or wood strapping (8 to 15 feet in length). Pipes can come apart into several pieces in order to facilitate transportation.



PROCEDURE

When one arrives at the site of the nest to be viewed, put the pipes together to the desired length or height. Attach the mirror and angle it to the degree you feel will give a good view of the inside of the nest. (Practice will improve your skill to the degree that you will usually be successful with one try). Next, a short section of pipe a little larger than the base of the one you are holding, may be driven into the ground as a holder. This is desirable if it is to be a lengthy viewing. In fact, this method is the best if the mirror is to be left up overnight or for any length of time. This is good as the adult birds will become used to it and it is always ready regardless of time of day. Remember — a pole can be used also, or strapping of various types.

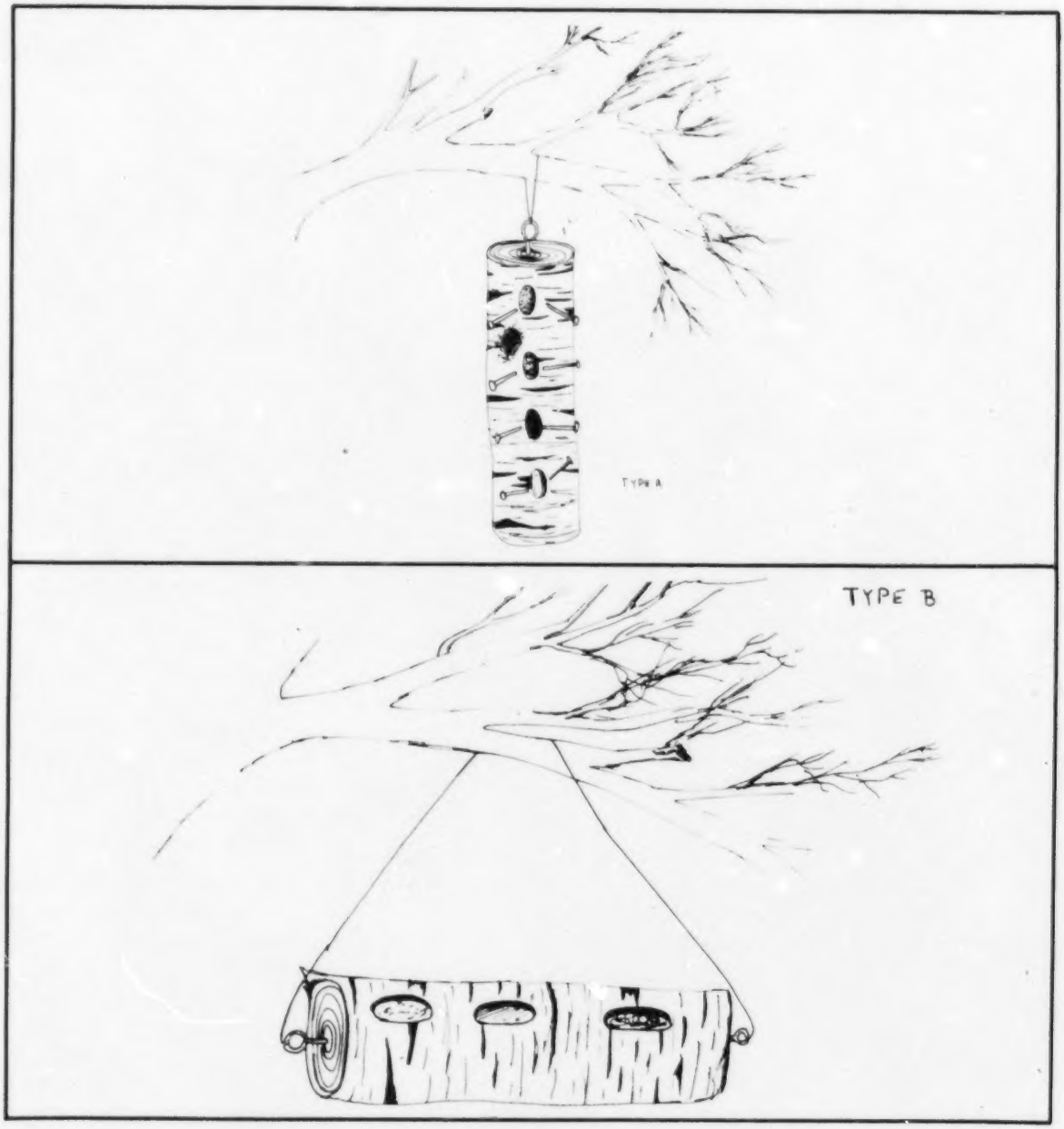


KNICK-KNACK INDUCER

The knick-knack inducer is one of the simplest hanging feeders to construct. Its main component is a small diameter log section of variable length. In the photos, these logs were drilled out with a 1" diameter spade bit in an electric drill to a depth of 1". A mixture of sunflower seeds and peanut butter were used in the feeding holes, much to the delight of the local feathered populations.

Several different types of feed may be employed on each feeder. In the vertical model, spikes were nailed into the log slight below and to one side of the holes, and were staggered to allow four birds to feed simultaneously without crowding. The horizontal model may be built with perches, but our test model showed them to be unnecessary.

If a drill is not available, ketchup bottle caps may be nailed directly to the log, and the feed may be placed in the caps. Allows longer perches if this :nodification is to be used.



WOODLAND BIRD BATHS

Once again we visit the used car lots, this time for wheel covers. (larger ones are preferred). Take the covers back to the shop and drill a small hole in the center of the cap. Now, all one has to do is carry along a few nails and a bottle to carry water in. Place the wheel cover on a small stump in a clearing with cover on the fringes offering good viewing, drive a nail through the pre-drilled hole; be sure it is snug to minimize water loss. (A little loss does not matter as it will last until you are through watching the birds). Fill with water from a nearby brook or pond. In some cases you may wish to bring water with you in larger amounts. These covers may be left or removed as you wish. They may also be put up higher in the trees and nailed to a dead limb or such.

THE ANT FARM

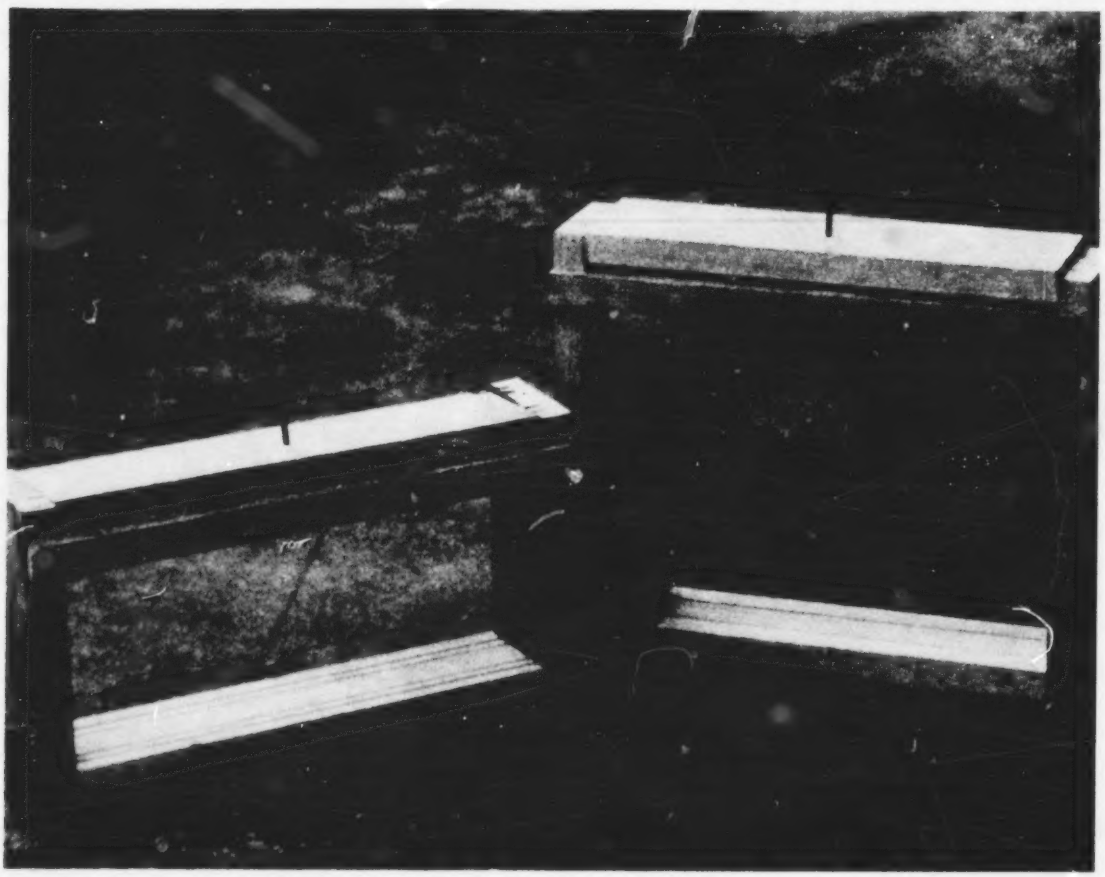
This is two sheets of plexiglass 1/8" thick set into three pieces of grooved scrap pine that exhibits a base and two sides upright with the two see-through plexiglass windows on each side. (See drawings).

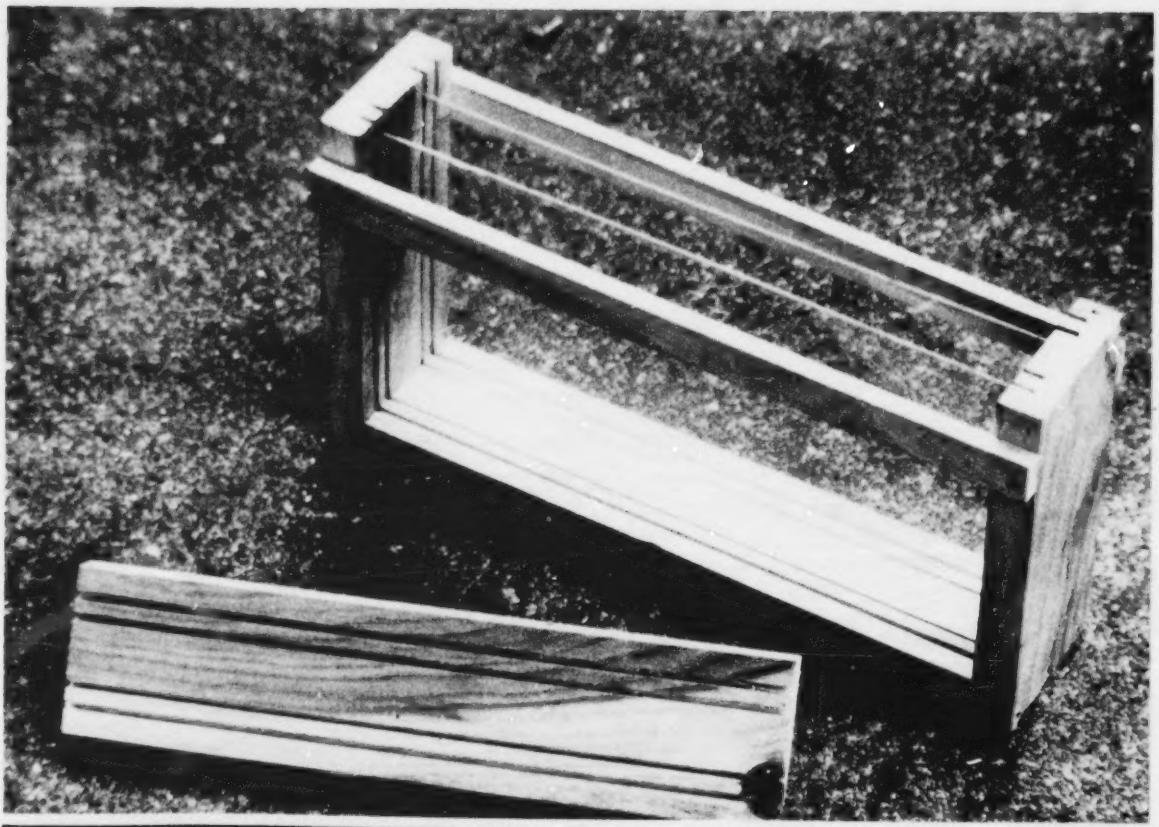
Another piece of pine forms the cover that is also grooved to fit over the top edges of the plexiglass.

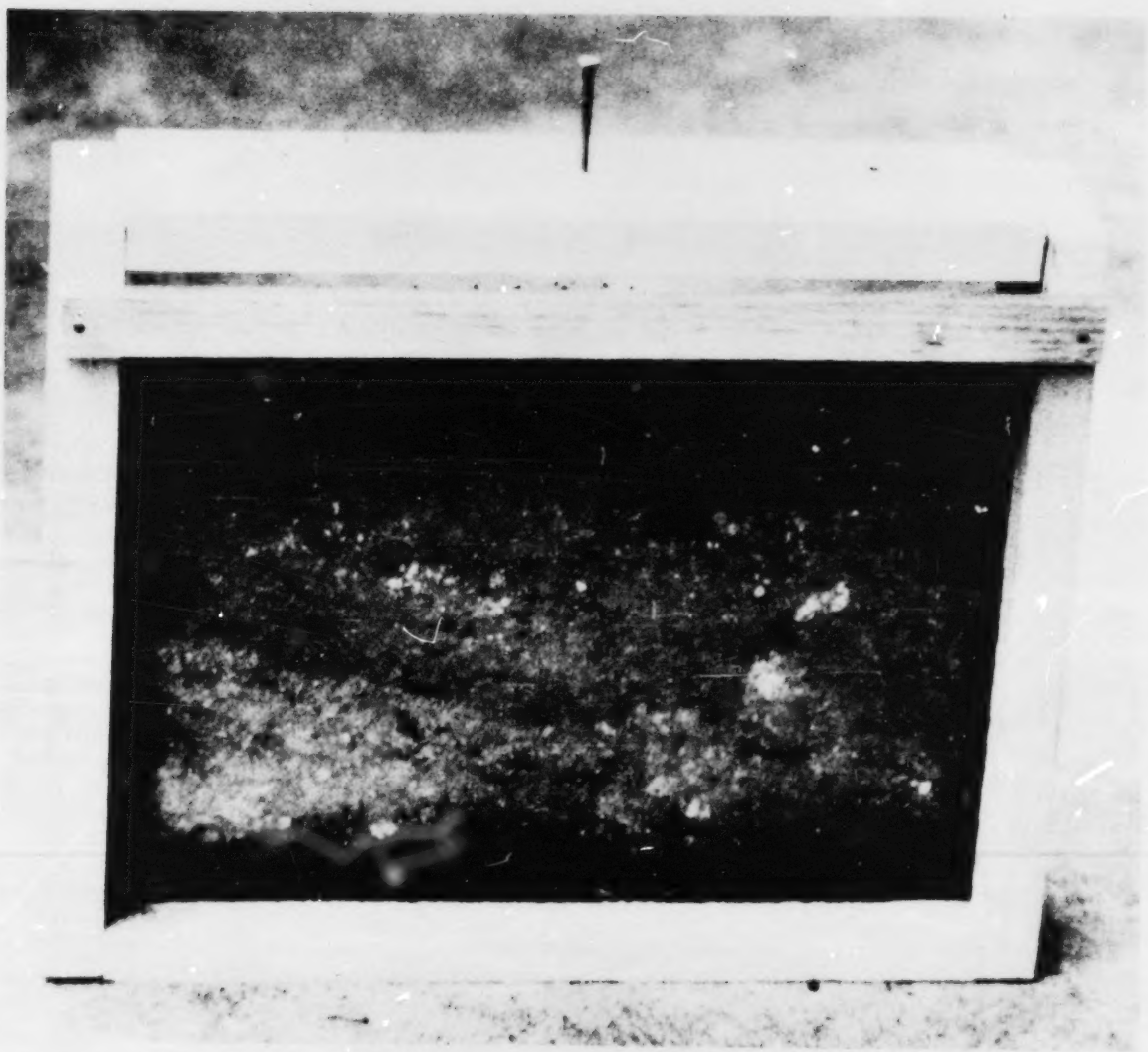
Locate an ant hill (powerlines are good sources) and shovel this into the farm making sure ants are in each spade-full. If you see one with wings trying to escape, catch her, for it is a queen. Get to the center of the mound to be sure of getting some food particles. Fill to 2" from the top and cap. Return to the lab and place in a cool spot where only distant rays of the sun can reach it.

By the time you are back at the lab, the busy ants will probably have excavated a lodge for their queen with a large escape canal extending from the lodge to the surface at one end. Many small cannusliculae radiate to the surface in all directions. These are used by workers and scouts exiting to and from the lodge. A large excavated area is located in one end opposite the queen's lodge. This is the community dump — a repository for wings and chitinized parts not edible to the ants.

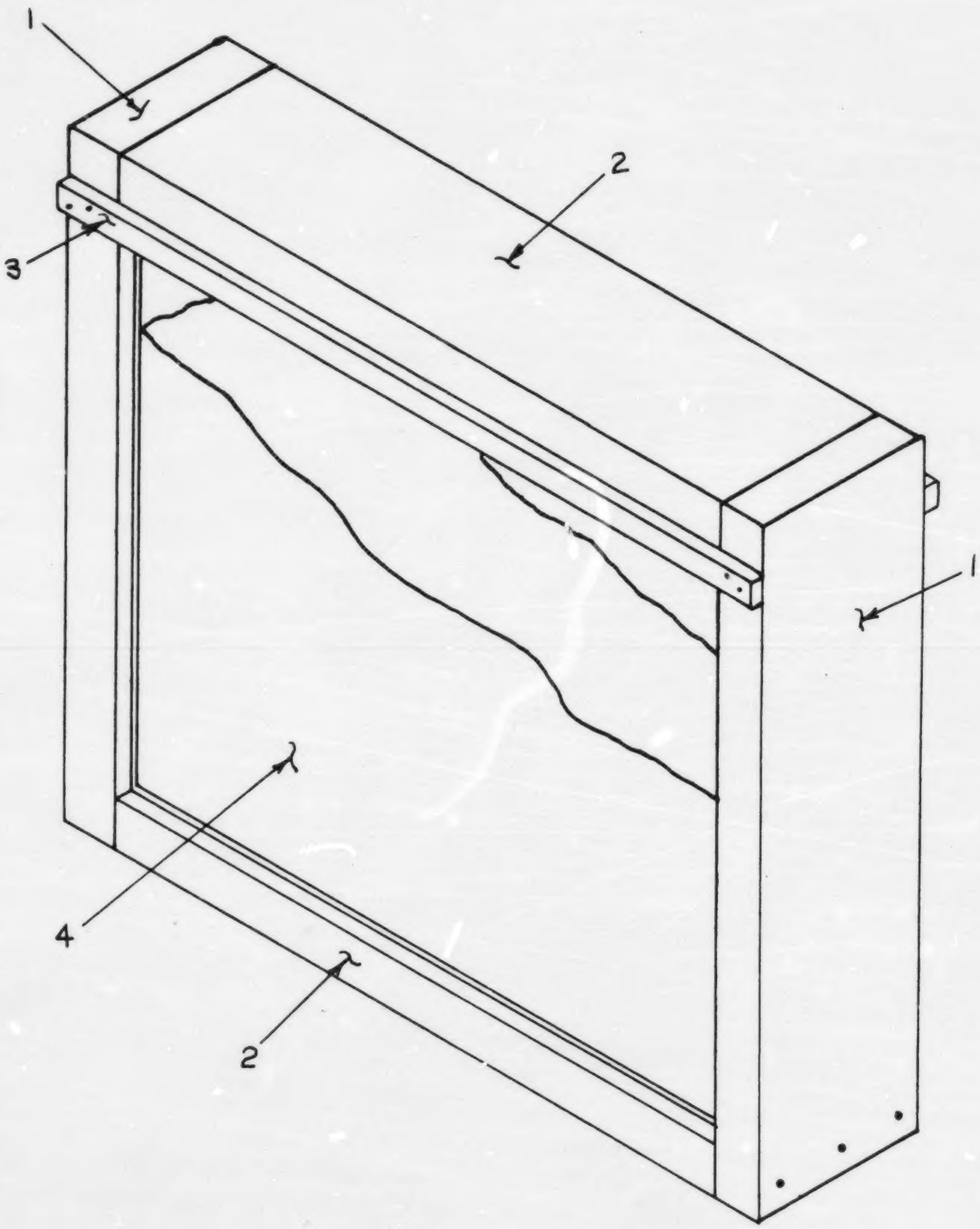
Many hours can be spent watching these interesting insects in their community living space. Live insects is the preferred food — dried millposs in hard times.

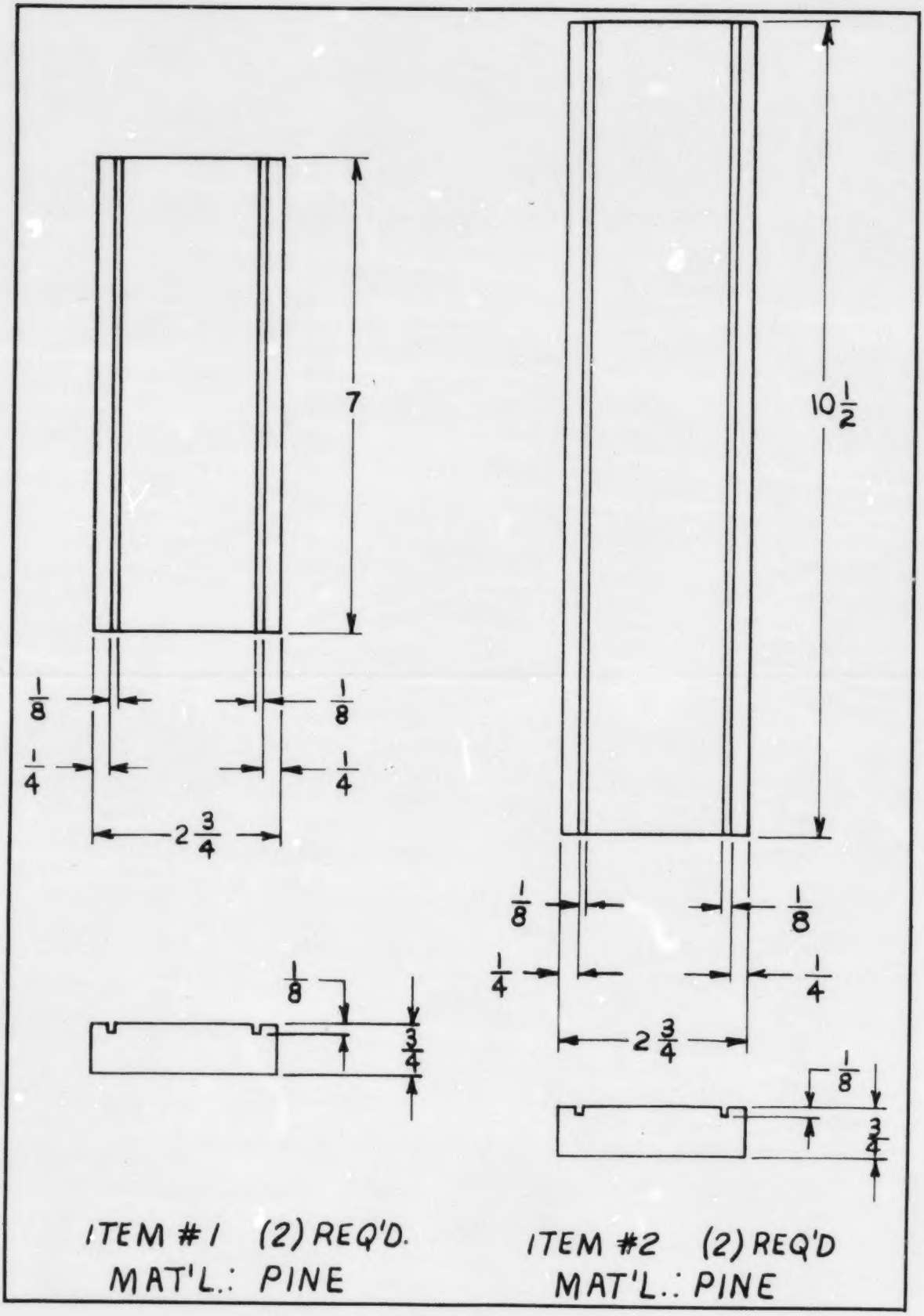






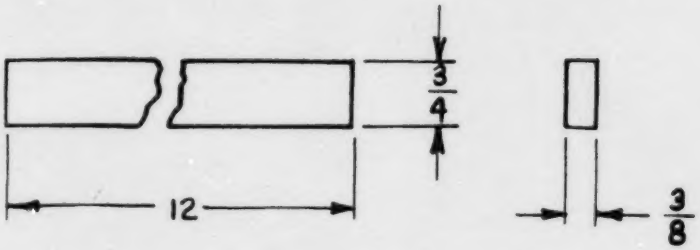
Phase III; ant farm (full) in hibernation. Student-made equipment program. Parkside Jr. High School, Manchester, N.H.


1
2
3
1
4
2

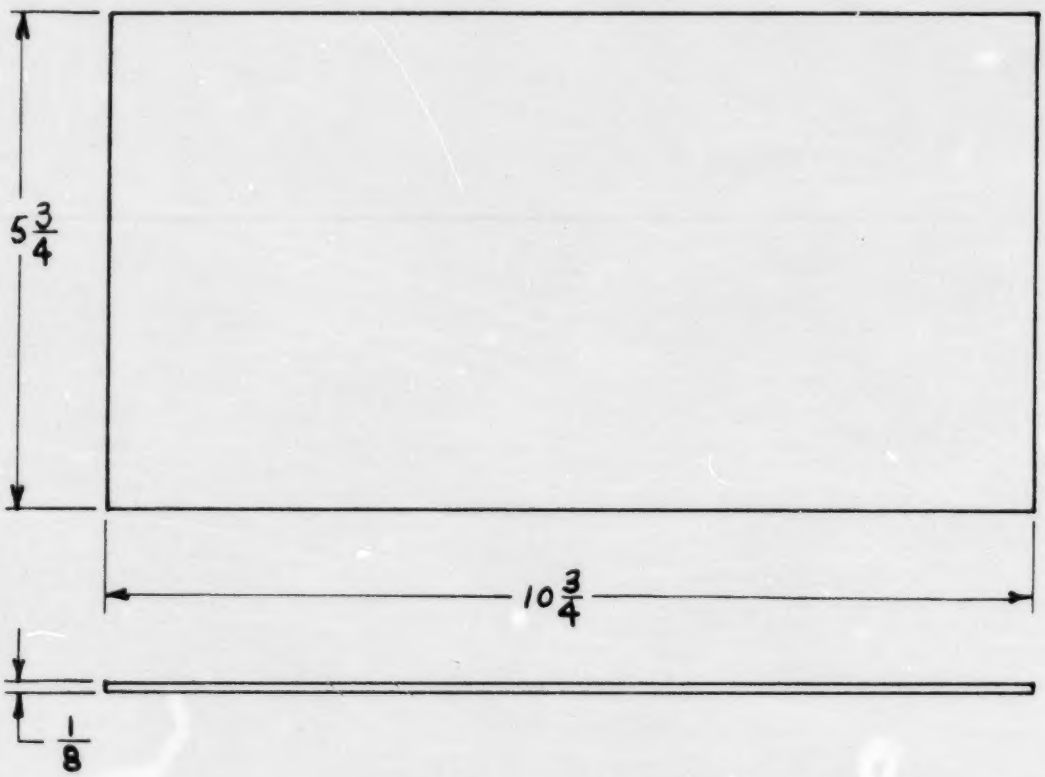


ITEM #1 (2) REQ'D.
MAT'L.: PINE

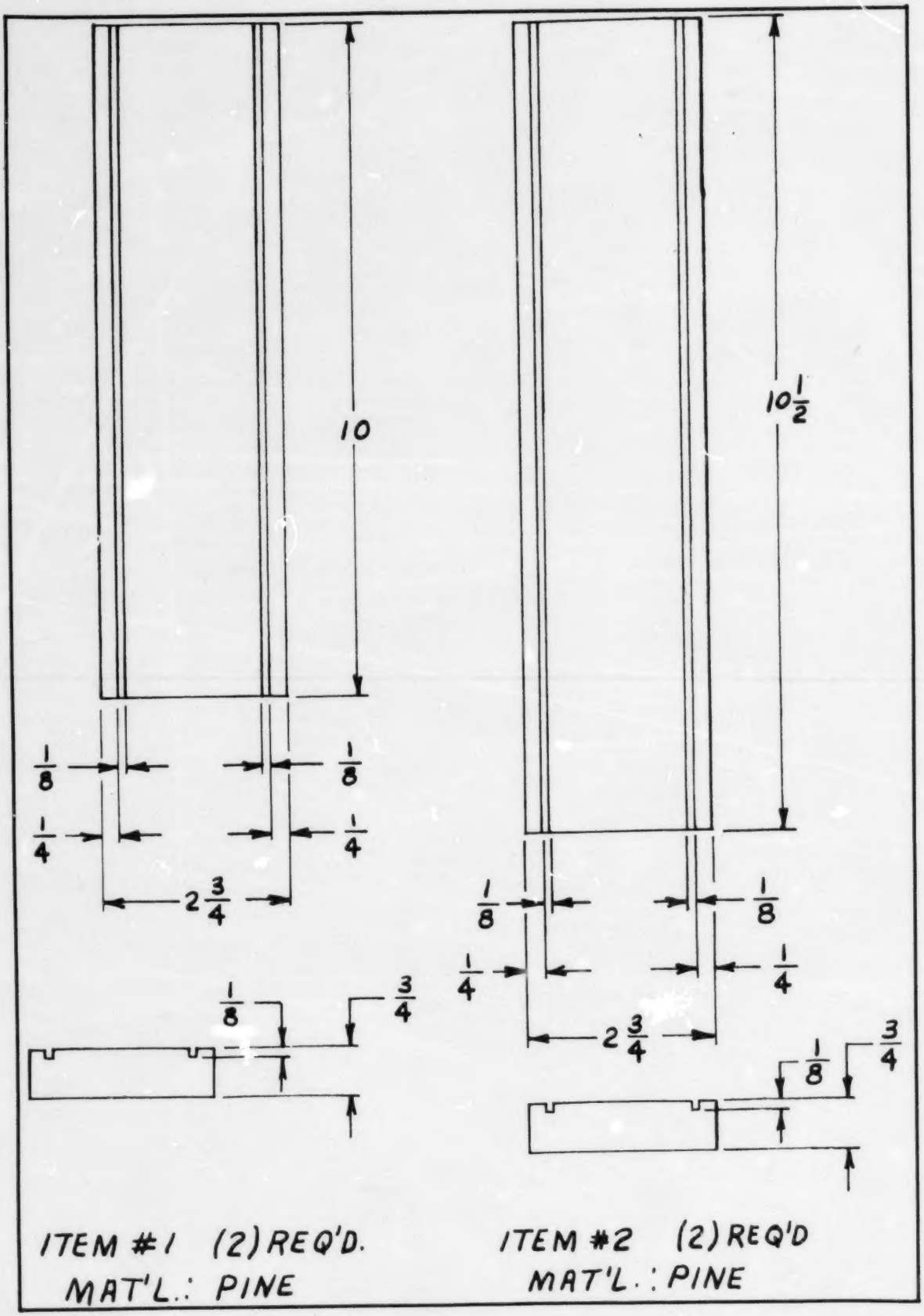
ITEM #2 (2) REQ'D
MAT'L.: PINE



ITEM #3 (2) REQ'D.
MAT'L.: PINE



ITEM #4 (2) REQ'D.
MAT'L.: CLEAR PLASTIC


10
1/8
1/8
1/4
1/4
2 3/4
1/8
3/4
ITEM #1 (2) REQ'D.
MAT'L.: PINE
10 1/2
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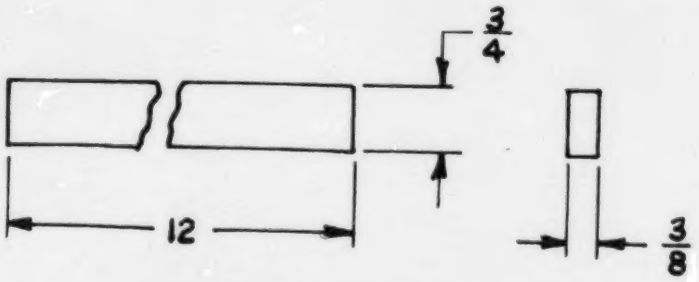
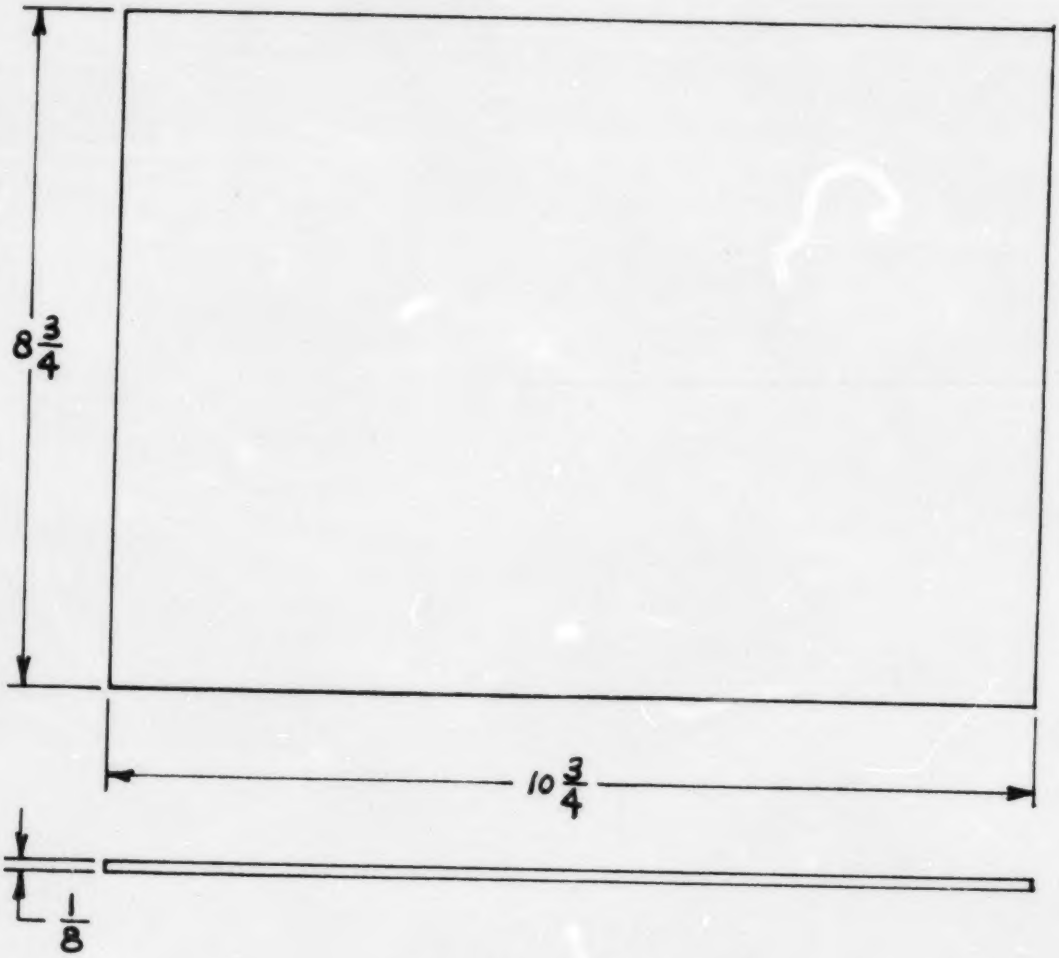
1/4
2 3/4
1/8
3/4
ITEM #2 (2) REQ'D
MAT'L.: PINE



ITEM #3 (2) REQ'D.
MAT'L.: PINE



ITEM #4 (2) REQ'D.
MAT'L.: CLEAR PLASTIC

INSECT NET

An effective insect collection net can be constructed by the students themselves, using easily available materials. The rim of the net is a re-bent coat hanger, with the diameter of the mouth being approximately 12". The hook of the hanger is wound around a 3 to 5' length of 1" diameter wooden dowel for use as a handle. If possible, hammer the final ¼th" of the wire into the dowel as a firm anchor.

The net itself may be composed of any fabric, but as a rule, cheesecloth is effective for large insects while nylon (especially 1 pantyhose leg) is adequate for smaller forms. Three triangular gores, measuring 1' wide by 3' long, are sewn together and folded over the wire rim with about a 1" hem. Sew the hem with a double row of stitching to assure maximum strength.

Collect insects by sweeping an area of tall grass about 6" above the tops of the grass.

After each sweep, take the insects to the tip of the net and dip it in a jar of killing agent, usually methyl or ethyl alcohol, and store them in another jar. Examine and classify the insects back in the classroom.

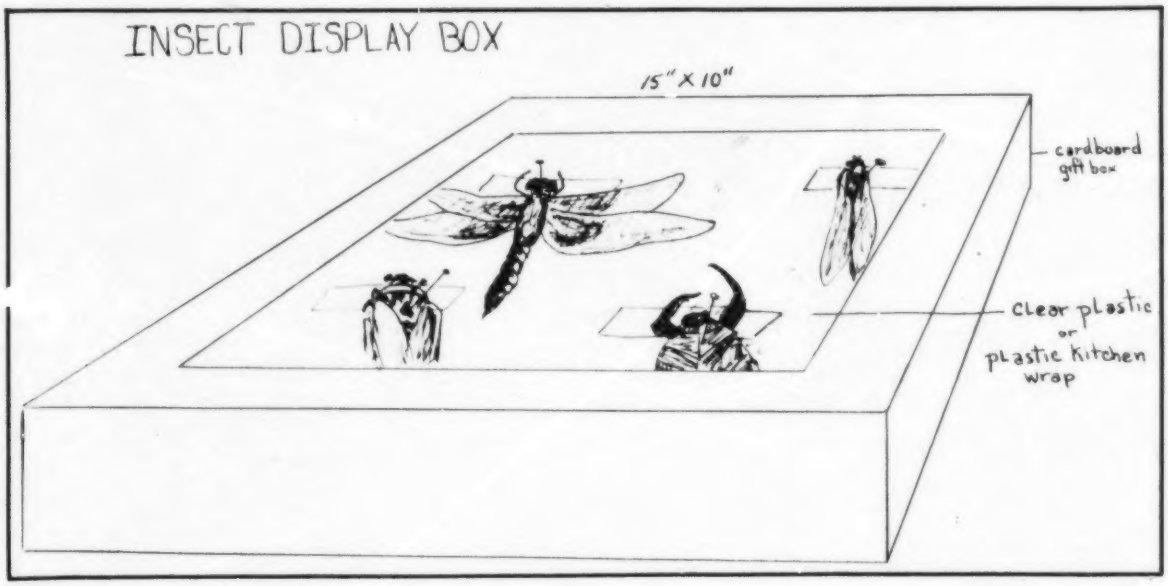
INSECT DISPLAY BOX

After collecting and identifying insects, it is often desirable to store them in a permanent mounting box. The materials necessary include a cigar box, ½" to ¾" thick styrofoam, small diameter straight pins (or insect pins if available), background paper (white), and clear plastic wrap (if desired).

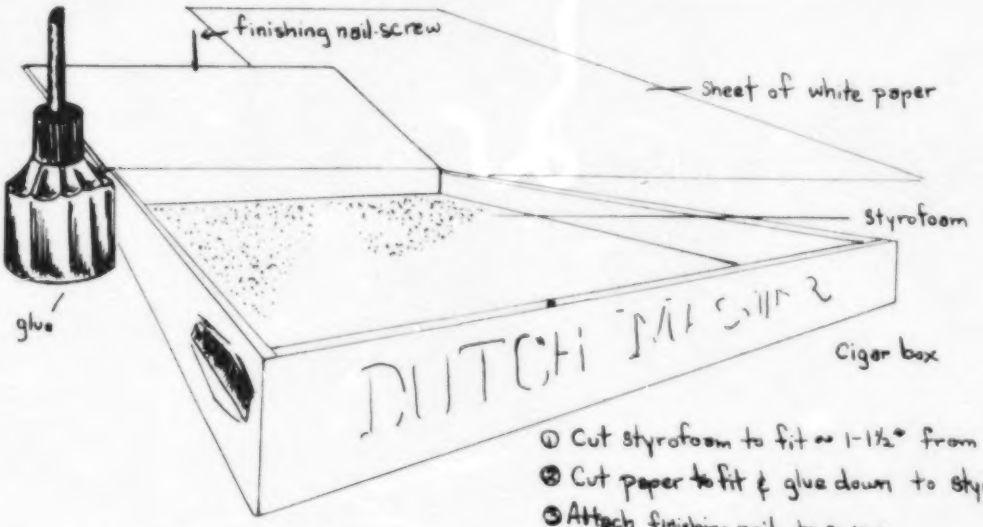
Place the styrofoam inside the box, trim it to fit snugly, and secure with white glue. Trim the background paper to the exact size of the styrofoam and secure with white glue. Arrangement of the insects can be decided according to individual preferences, but rows of each order with the insects arranged according to size from largest at the top to smallest at the bottom gives an organized and pleasing display.

Labels should be written with a fine point pen. They may be placed over the larger insects, but with smaller specimens, arrange the labels beneath and to one side.

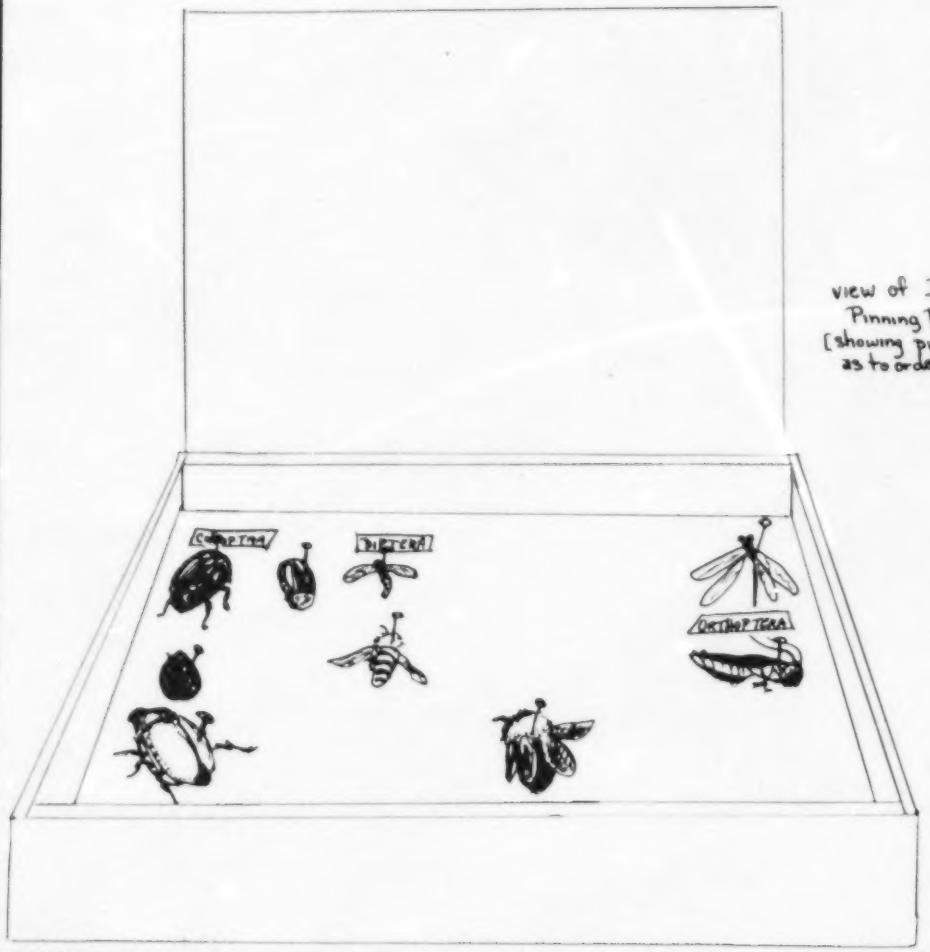
If desired, the top cover of the box can be cut out with a three fourths inch border left. Staple clear plastic inside the cover, creating a window. Secure the cover with a tack through the cover and into the front edge.



INSECT/STYROFOAM PINNING BOX



① Cut styrofoam to fit ∞ 1-1½" from top.
② Cut paper to fit & glue down to styrofoam
③ Attach finishing nail to cover

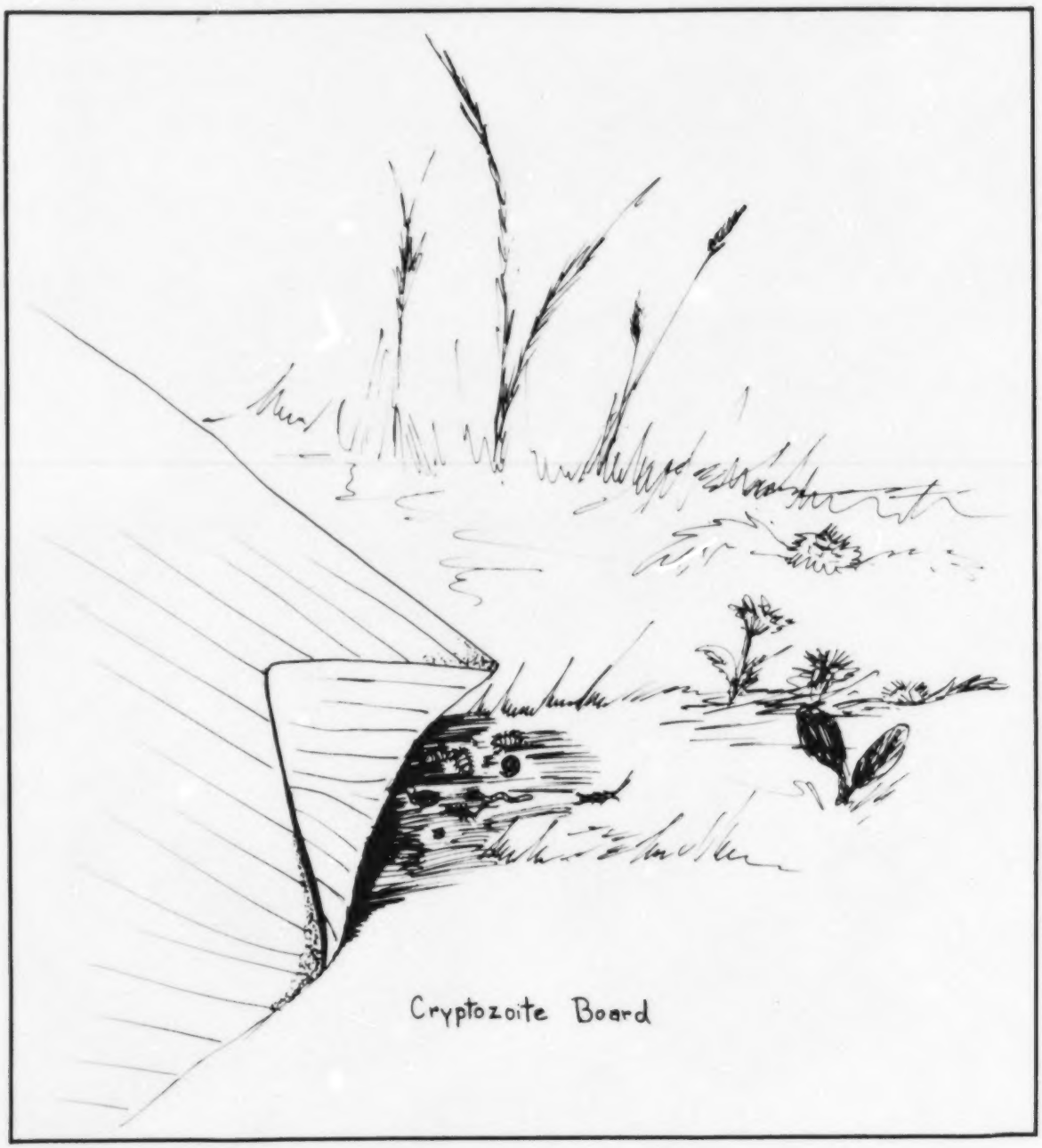


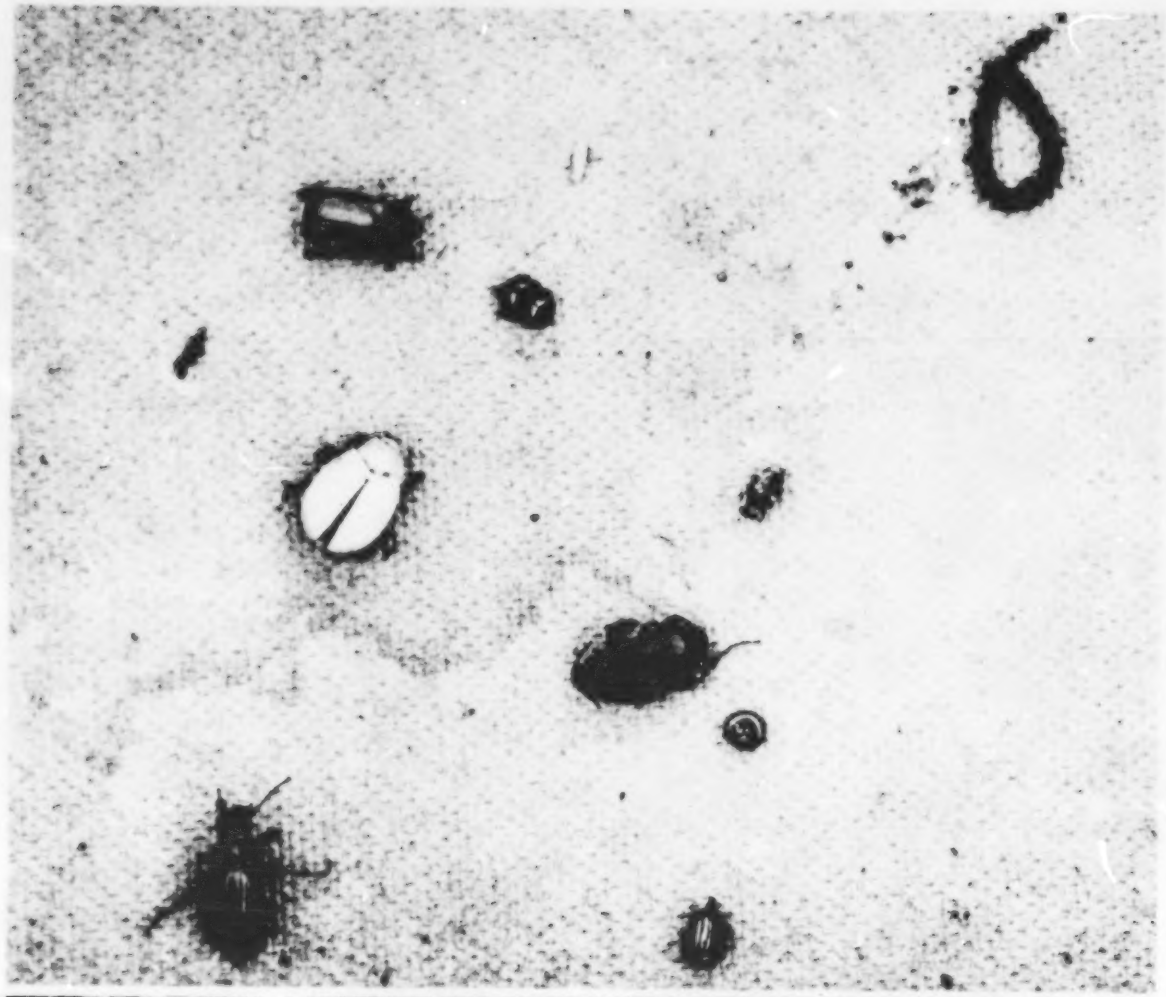
view of Insect/Styrofoam Pinning Box
[showing pinned insects labled as to order]

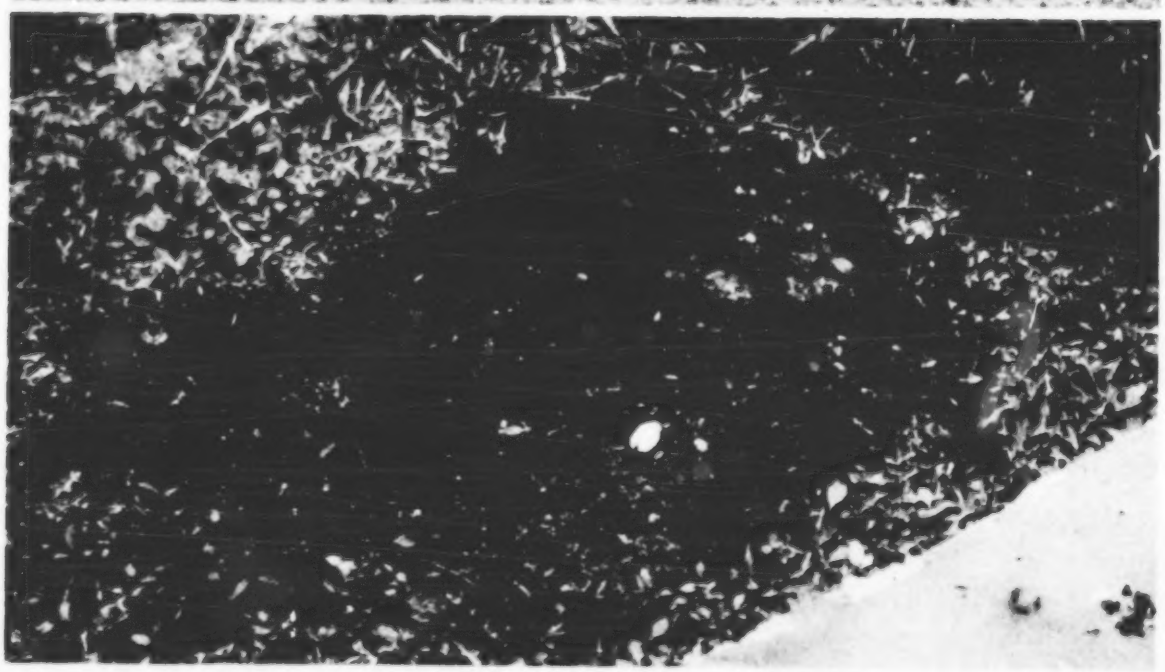
CRYPTOZOITE BOARD

The cryptozoite board is utilized in field investigation of burrowing insects and animals. It is nothing more than a sheet of plywood or particle board that is placed on the ground and examined for species that have gathered beneath it at a later date. Field investigations with cryptozoite boards have yielded up to 144 different species over a two-year period in an old field.

From a statistical analysis standpoint, a series of crypto-boards, each 1sq. foot in area, laid out over a field and left for 1 week would provide easily tabulated data for population density studies. Also, boards set out with different substrates (grass, leaf mulch, wet mulch, dry and wet hay, and different kinds of bark) should attract different species.







THE TEA CADDY — AS A PLANARIA COLLECTION DEVICE

Many homes have the old aluminum tea caddys tucked away in some drawer, cupboard or cabinet, forgotten with the arrival of the tea bag. Our children today would be hard put to figure out what is was used for. Well, instead of filling it with tea and letting it hang in a pot by its chain, let us instead stuff it with macerated liver (chicken, pork or beef) and screw the two halves together. Now, tie a string to the chain and let it bounce upon the water of the brook near moss covered rocks. Attach the other end of the string to a corduroy or bridge, tree branch, etc. Planaria will come to this like no other lure. Return 24 hours later for your cross-eyed worms.

PLANARIA COLLECTION DEVICE

HESTER-DENDY SAMPLER

From a piece of hardboard, marine plywood or plexi-glass (scrap pieces) ¼" thick, cut out ten (10) squares. All squares must be 3" X ¼". Now take another piece or several smaller pieces of 3/8" material same as above (scrap) and cut them into ten (10) 1" squares.

In the exact center of all squares drill a hole. Starting with a 1" square insert an eyebolt that is six inches (6") long by ¼" through the center hole and then add a 3" square. Continue this alteration of 1" and 3" squares until you have added (9) nine 1" squares and eight (8) 3" squares. At this point cover the 9th 1" square with two (2) of the 3" squares and finally add the tenth 1" square on the eyebolt along with a washer and tighten this entire set-up with a wing nut. The useable surface on this piece of apparatus total (1) one square foot thus making a compution of the biomass an easy matter for a given segment of the aquatic or marine ecosystem under consideration.

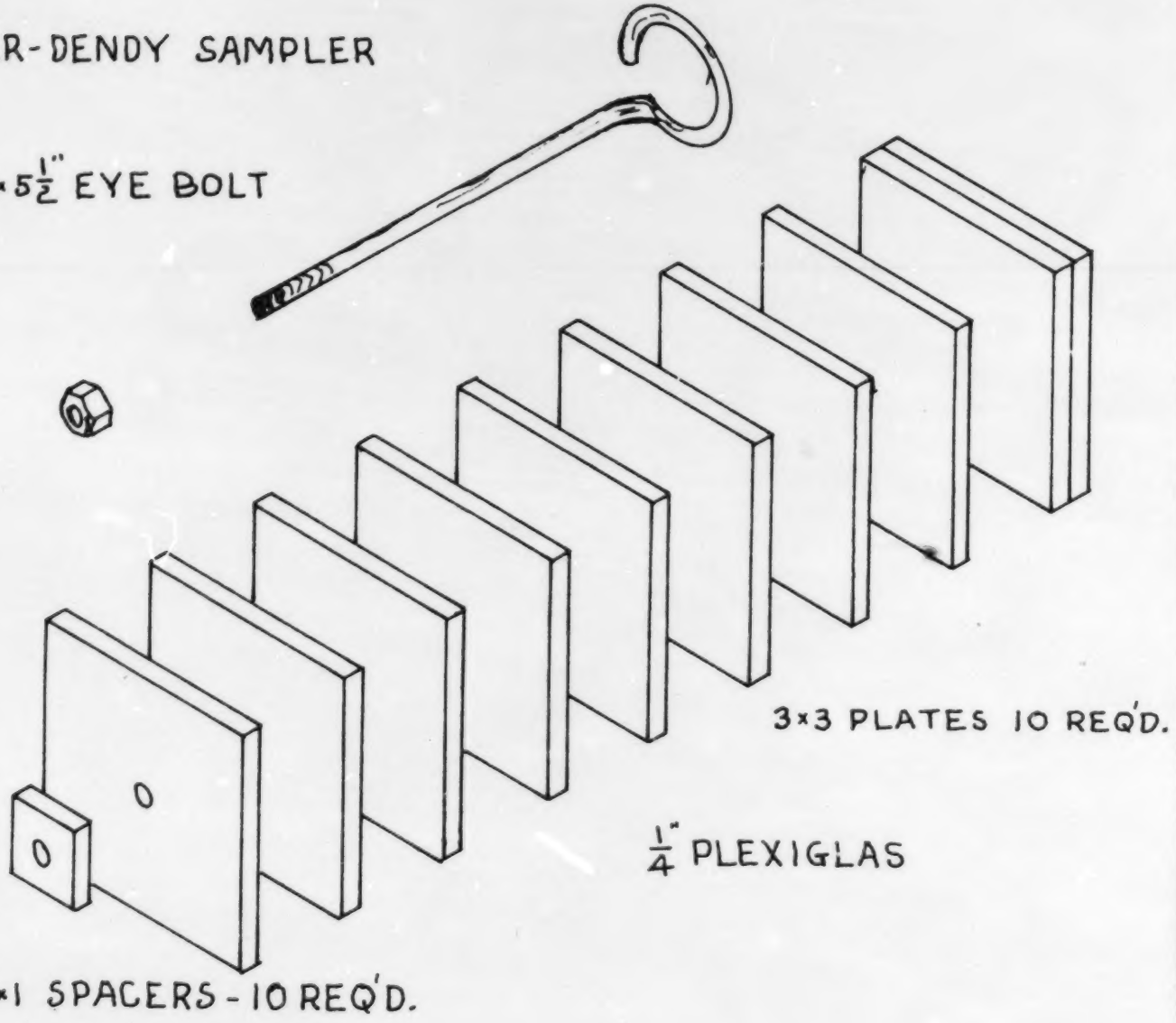
The Hester-Dendy sample is mainly used to study macroinvertebrate life forms on the bottom of ponds, lakes, streams and estuaries. The square form of removable substrate upon which the macroinvertebrates can attach themselves. The 9th and 10th 3" square form a crack into which cryptozoite forms may hide along with microscopic forms. To do an accurate analysis of the bottom forms one should set out enough samples in both the (Lotic) or running waters and the (Lentic) or still waters. These two types of habitats have different benthic populations.

If the bottom substrate is sand, gravel or rock, it is permissible to place the sampler on the bottom. If the substrate is muddy, gooey or layers of loose detritus, the sample should be suspended just off the bottom. This prevents an accumulations of "gunk" from whatever substrate is present thus allowing for uniformity of types collected. The Hester-Dendy Sampler may be tied to branches or roots that extend out over the water. They may also be suspended by a heavy nylon line tied to the eyebolt and attached above to a plastic bleach jug. If the above method of placement is used it is advisable to unscrew the wing nut and using a strong fishing line to which a weight is attached, tie this to the nut and rescrew it. Now, lower the sampler to its position with the jug floating above as a buoy. This will prevent all samples from being blown across the pond or lake by a heavy wind or current. Complete coverage should include both shores and the middle of the body of water being tested. Allow the samplers to remain for two to three weeks. Once collection has started all samples should be removed one at a time, disassembled and the organisms removed. This may be done by scraping the squares using a laboratory spatula, over a white enamel pan. If the examination of the organisms is to be longer than an hour it has been recommended that the samples be placed in a plastic bags into which some water from the surface has been added. This will prevent dehydration of the specimens.

For longer periods cool the bags with ice or refrigerate. As they are scraped off the squares, count the organisms and identify what is found upon each square. Be sure squares not being counted are protected by leaving in the bag or some cooling device.

After one has scraped all squares and identified all specimens the results should be used to compute diversity. From all samples collected across a specific body of water a good indication of biomass may be computed. An excellent reference for the material in this article is, Dendy, J.S. and Hester, F.E., "A Multiple Plate Sampler for Aquatic Macroinvertebrates." *Transactions of the American Fisheries Society*, 91(4):420-421, 1962.

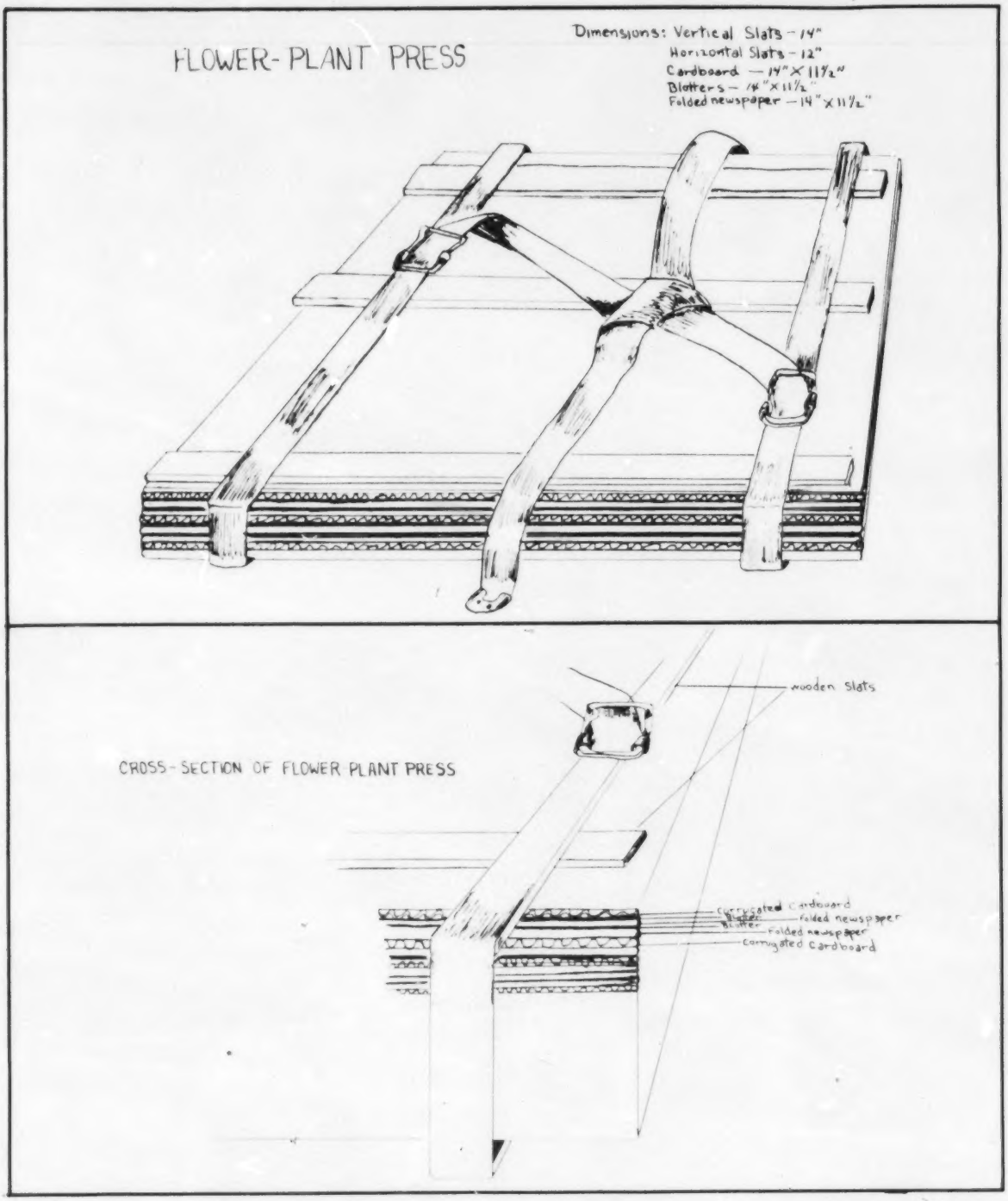
HESTER-DENDY SAMPLER



FLOWER PRESS

In construction, the flower press is identical to the field press shown in *STUDENT-MADE ENVIRONMENTAL STUDIES EQUIPMENT*, VOLUME I.

Pressing and preserving flowers require increased attention to herbarium-sheet layout to assure maximum viewable detail of the blossoms. Wax paper may be needed in the case of pressing, floating, or submergent vegetation to prevent the wet leaves and stems from sticking to the newspaper. Also, blotters should be changed several times to ensure complete drying.



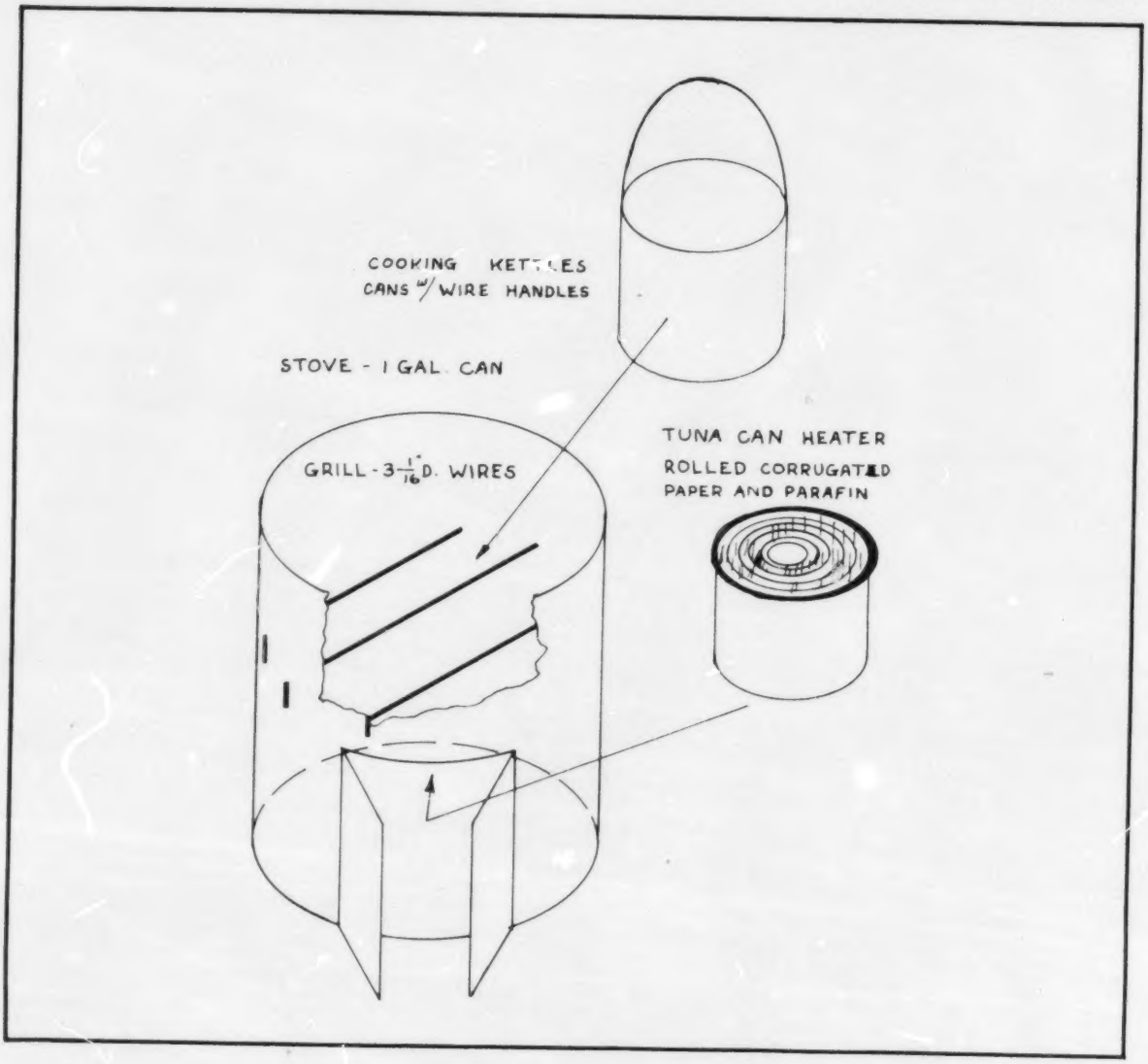
TUNA CAN HEATER WITH STOVE

The tuna can heater is a simple, light-weight, inexpensive source of heat out in the field. The heating element is simply an empty tuna-sized can into which a 1½" wide strip of corregated cardboard has been rolled.

Melt several blocks of paraffin or some old candles in another can, and pour this over the rolled cardboard until it is thoroughly soaked, then set the completed heater element aside to cool.

To construct the stove, obtain a 1 gallon tin can (often used for institutional-sized portions of food in cafeterias) and remove the top end plate. From the bottom edge, open a two inch high, 4" wide T-shaped cut, and fold out the two flaps that are formed. Using a punch or an awl, punch 3 holes in each side of the can about ¾ to 1" apart, and about 2" down from the top of the can. Insert lengths of 1/16" diameter wire (coat hanger stock will suffice) through the holes as seen in the diagram. These form the grill. With a pair of pliers, bend over all sharp edges to reduce the changes of getting cut.

To use, clear a space on the ground of all debris, leaf litter, etc. Take the stove and place it in the cleared space with the access flaps open. Place a heating element beside the stove and light the center of the cardboard roll. As soon as this ignites, slide the tuna can into the stove, roughly center it under the grill, and close the flaps partway. Allow a minute or two for the flame to spread over the entire



cardboard roll. The stove can now be used to heat a coffee pot or pan of water. Enough heat is produced to boil water in ten to fifteen minutes. Take precautions not to touch the sides of the stove with unprotected hands, as burns could easily result. When finished, make sure the fire is out, and the area is left as you found it.

LITTER-CAN STOVE

In construction, the litter-can stove is similar to the tuna-can heater stove. The difference is this modification allows forest litter (twigs, leaves, needles, bark) to be burned. Punch a line of holes around the lower wall of the can to supply ventilation.

Punch the grill holes 3 inches down from the top. This is necessary due to the intermitant heat from a litter fire. Use coat hanger wire (1/16" diameter) for the grill.

This stove is usable all year round. Dry litter can be found beneath pines in the winter. The stove is capable of heating several cups of water to boiling in 15 minutes.

TERRARIUMS

A terrarium is a miniature closed ecosystem entailing nutrient recycling, hydrologic cycling, and gas equilibrium. It is a self-enclosed world requiring only an input of light from the outside to maintain itself if properly constructed.

Terrariums can be constructed in any container, glass or plastic, that will admit enough light. Size is only restricted by the size of the plants to be maintained. A small jar could contain a bit of moss, some lichens, and a liverwort and function quite well. A narrow necked bottle can be used by making miniature long-handled garden tools; however, students prefer to cut the bottle in half, arrange the plants, and then epoxy the bottle back together.

To cut a bottle, take a glass cutter and scribe a line around the outside of the bottle. Heat the scribe line with a bunsen burner or propane torch for two minutes, then quickly submerge the bottle in cold water. If it doesn't crack along the scribe line, reheat and submerge again until it does crack.

Start by filling the bottom with three fourths inch of gravel. Cover this with one fourth inch of activated charcoal or charcoal/limestone, to a depth of 1". Now add a soil mixture of one part vermiculite, 1 part peat, and 4 parts sterilized top soil (available from garden suppliers). If succulent plants or cacti will be used, include approximately ½ sand to the soil mixture. Gauge soil depth by 1 to 3" of soil per foot of container height. A rule of thumb is that the drainage material plus soil depth will equal ¼ the container height.

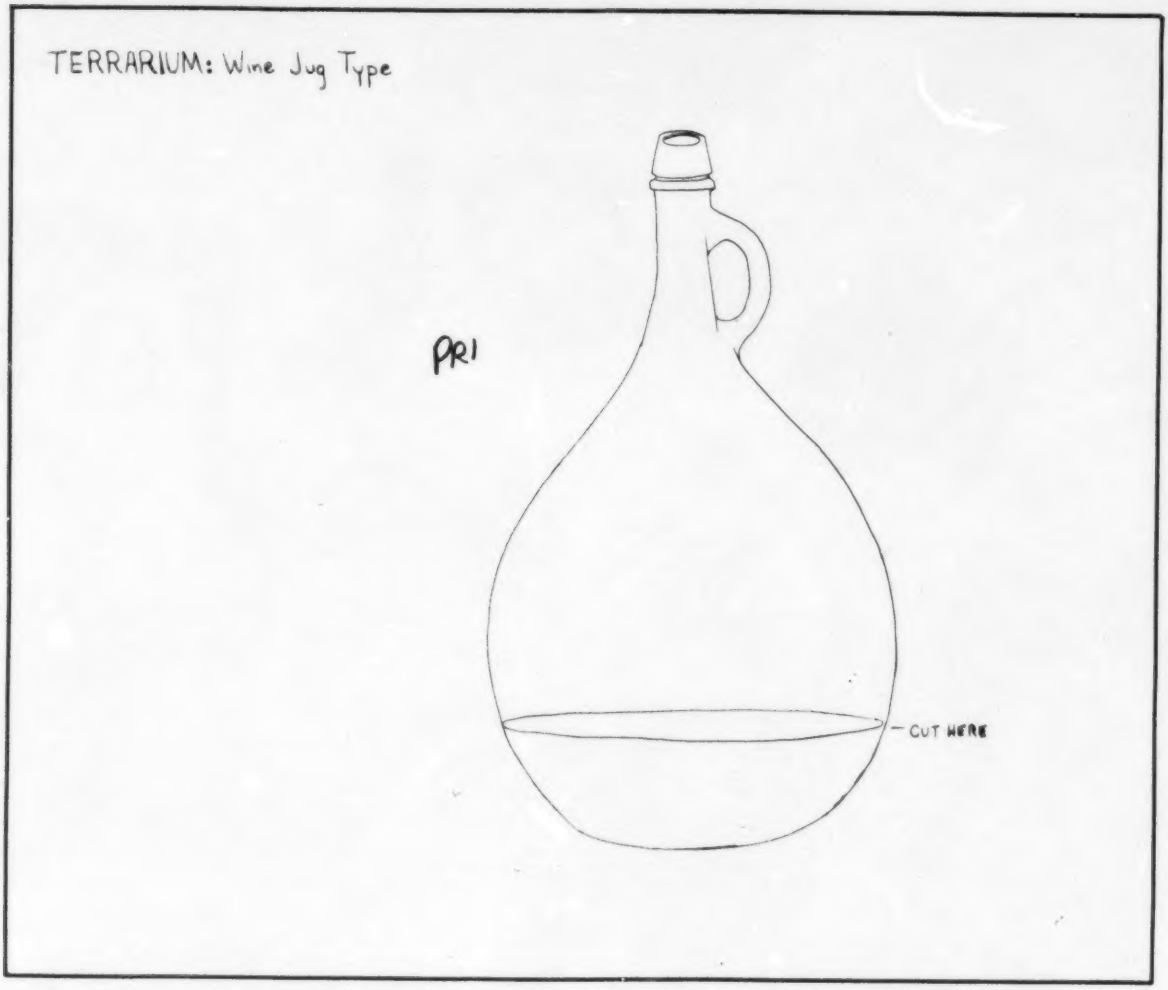
Plants selected for a common terrarium should be close to each other with respect to soil, temperature, light and water requirements. Most house plants will flourish in terrariums as well as some exotic plants available through local florists. Remove the plants from their pots, remove any excess soil from the roots, place in a hole in the terrarium soil, and lightly pack more soil around it. Avoid letting leaves touch the container sides because this will invite saturation rot and could induce mold growth. Decoration may also be added.

Mix equal parts of epoxy resin and hardener. Apply to both edges of the bottle evenly with a probe or toothpick, avoiding runs and drips. Join the top and bottom and don't apply any stress to the joint for at least a day.

Water the plants very slightly with distilled water or tap water that has stood out at least overnight to lower chlorine levels (if present). Over watering will cause condensation inside the container. Allow the condensation to evaporate before sealing.

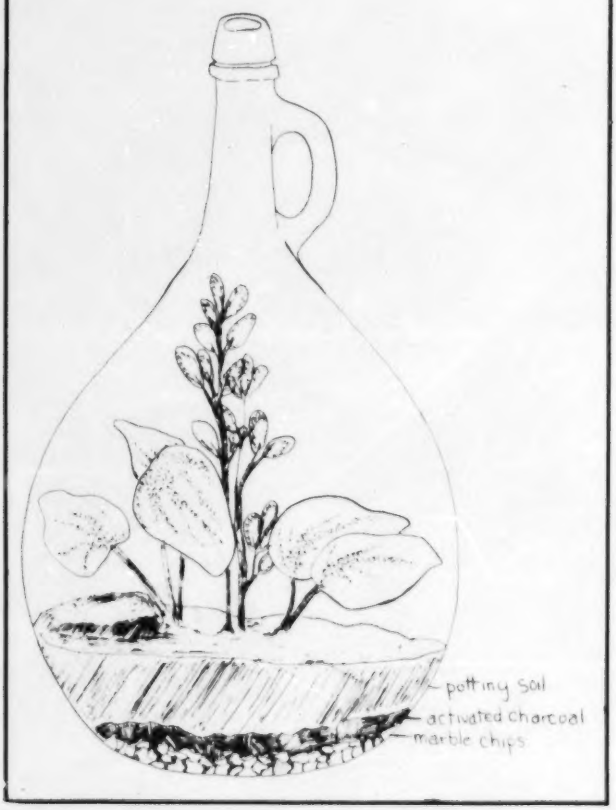
Once sealed, avoid contact with direct sunlight due to excessive heat build-up. If all factors are in balance, the terrarium could remain closed for a year or more without further maintenance. A general light level of 500 footcandles (a sunlit room) is sufficient for most terrariums, but this may vary with direction of exposure and time of year.

Open terrariums will require minimal watering. A successful closed system may condense mist on the container in the morning, but this will clear by afternoon.



TERRARIUM: Wine Jug Type

TERRARIUM: Wine Jug Type [cut & epoxied]



ARMY

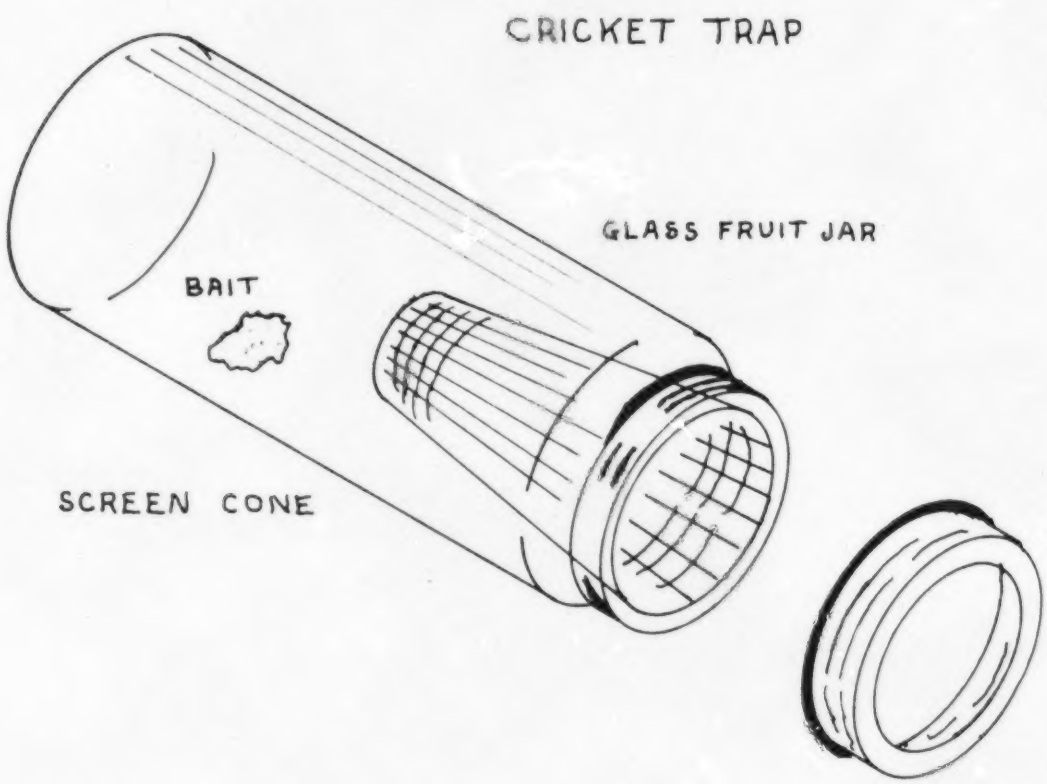
CRICKET TRAP

This easily-fabricated device allows collection of crickets for insect study. Construction centers around an ordinary mason jar with a screw-on lid.

Using a piece of scrap window screening, fashion a cone with an open end, the diameter matching that of the mouth of the jar. Cut off the tip of the cone, so that the diameter of the small end of the taper will be about 3/8". Cut the center of the screw-on cap out, leaving about ¼ rim all around.

To use, prepare a cricket-enticing bait by adding about ½ cup shredded grass to 4 tablespoons of molasses. Mix until a cohesive clump of grass is obtained, and place this in the jar. Insert the screen as shown, replace the cap, and set the trap outside.

The shape allows the cricket to crawl inside to get the bait, but prevents exist, due to the necessity of flying to the small end of the cone. The cricket can't fit through with its wings spread.



SOIL SAMPLE CUTTER

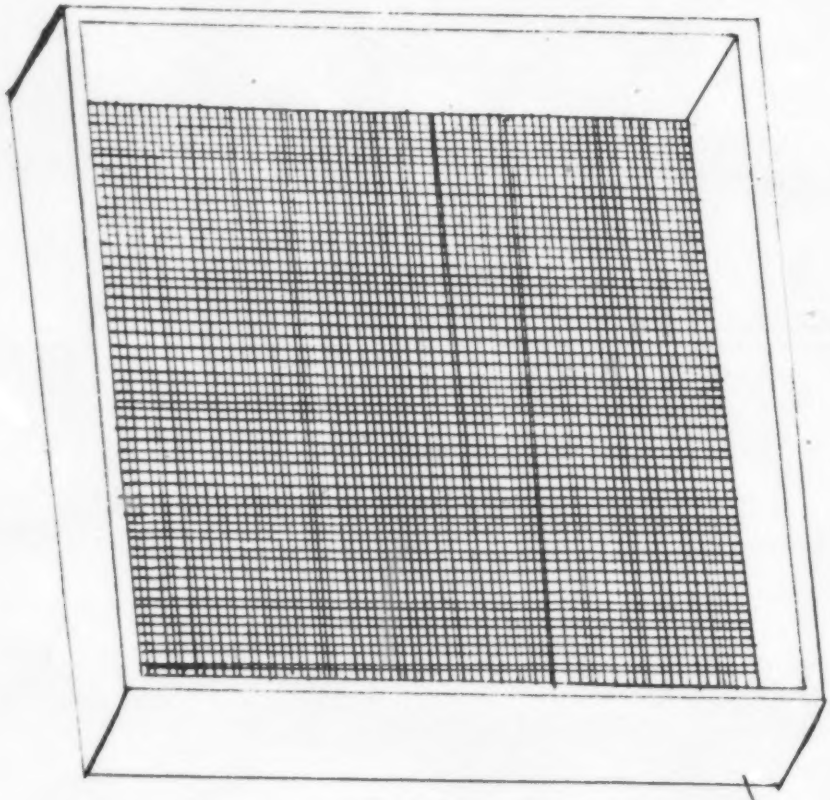
This simple device, patterned after commercially produced tulip bulb planters, allows vertical soil samples to be taken. Scrap sheet metal is the main component, whole thickness will be determined by the consistency of soil to be sampled and the gauge of sheet metal available.

After cutting the sampler out of the metal, fasten together by drilling holes and securing with pop rivets. Use wood screws to attach the handle.

The soil sampler can be used to pick out soil horizons, to do pollen counts in lakeside mud, and also to obtain clean snow for precipitation pH studies.

SOIL SIFTER

For approximate analysis of soil samples a simple soil sifter can be constructed from scrap lumber and screening. By measuring the grip size of the screening used, approximate grain sizes can be found. This data can be recorded by o/o weight of each grain size function.

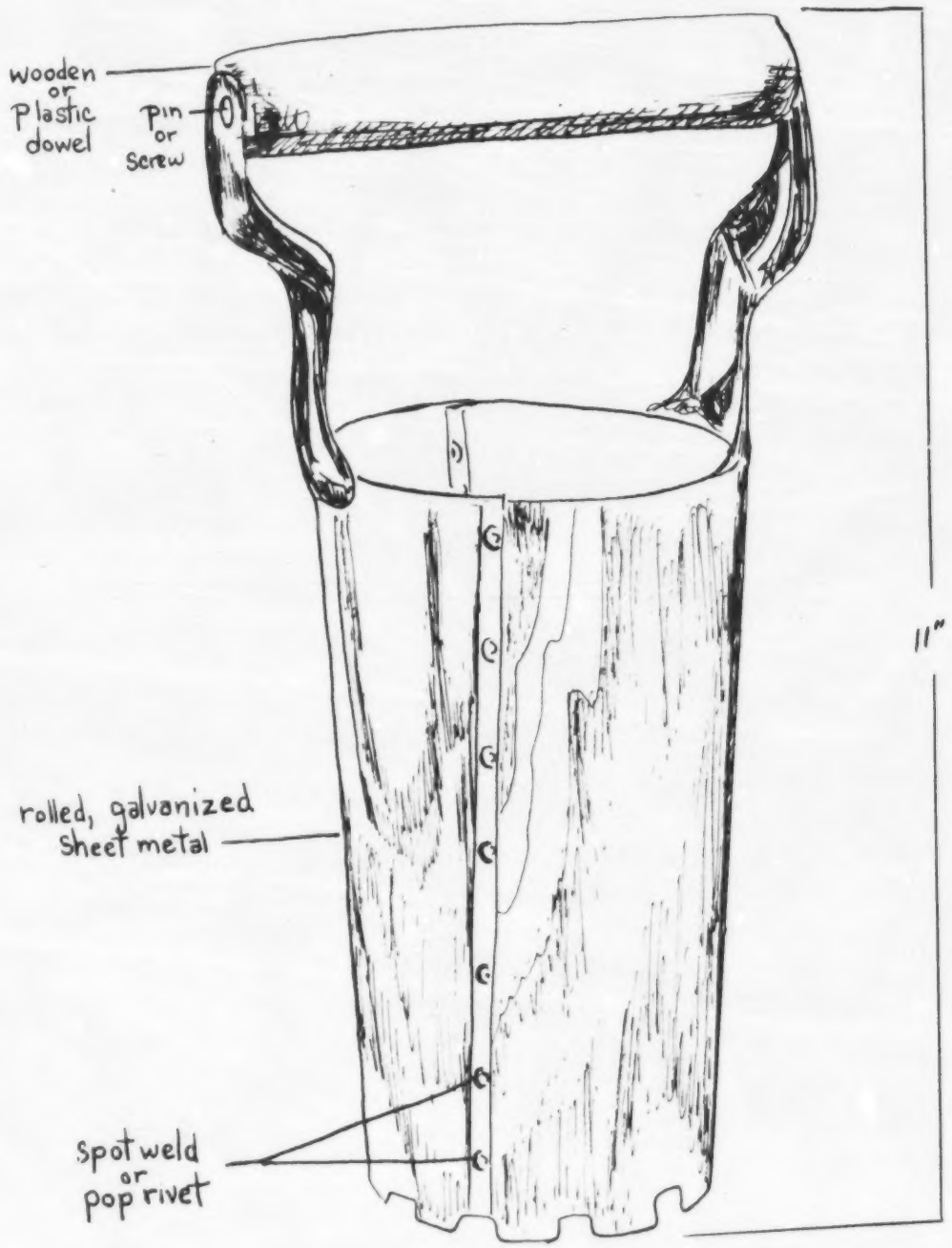


COFFEE CAN TRAP

Another insect trap that proves extremely effective is the coffee can trap. Constructed from a large size (2 lbs) coffee can buried to ground level, several traps can be set out with a minimum of effort for a large insect collection.

The can with any suitable bait inside is covered with a scrap of coarse screening. Protect the opening from rain with a scrap board placed in a lean-to position. Insect will crawl through the screen, but won't fit back through while in flight.

SOIL CORE SAMPLER



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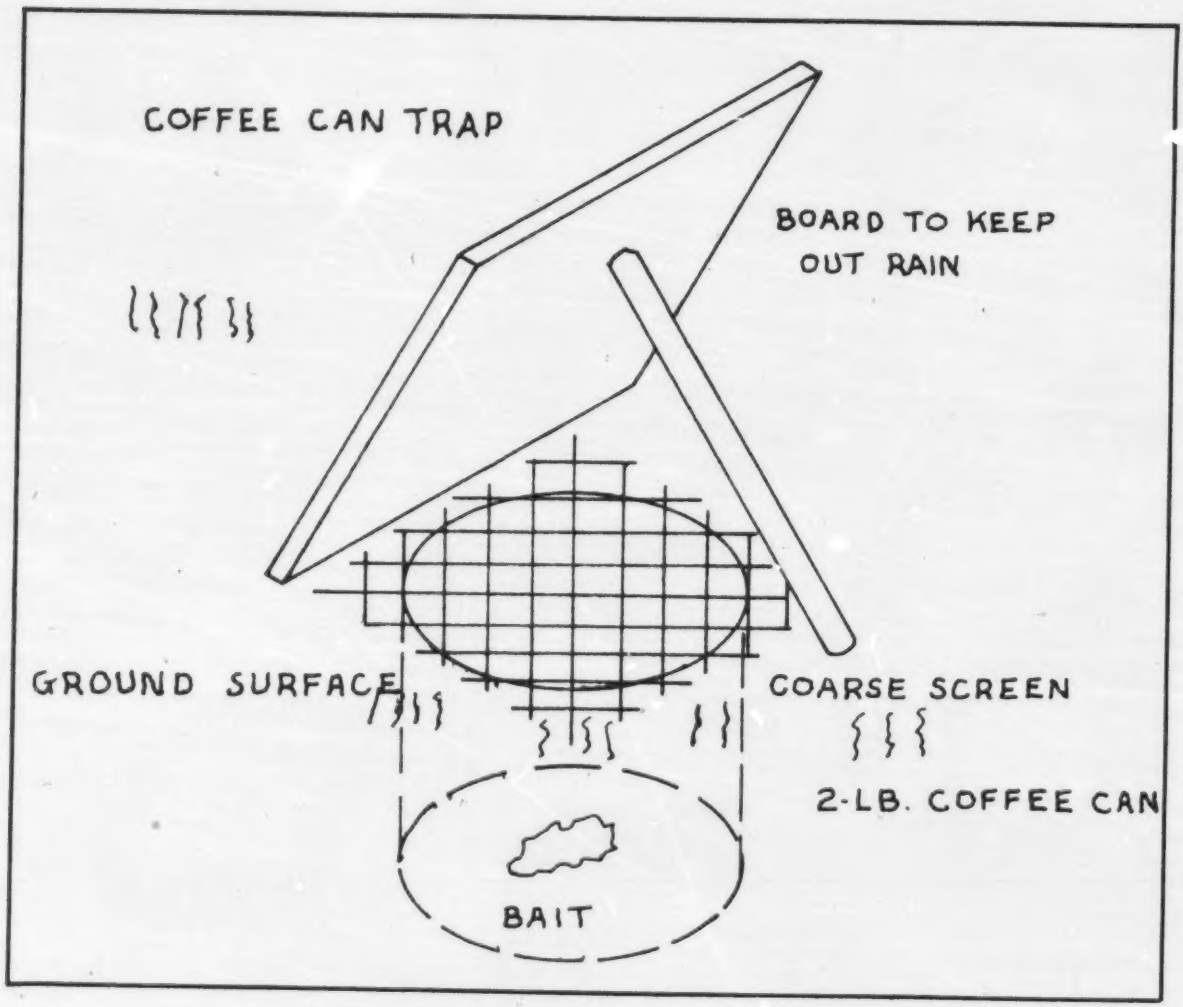


AIR FILTER

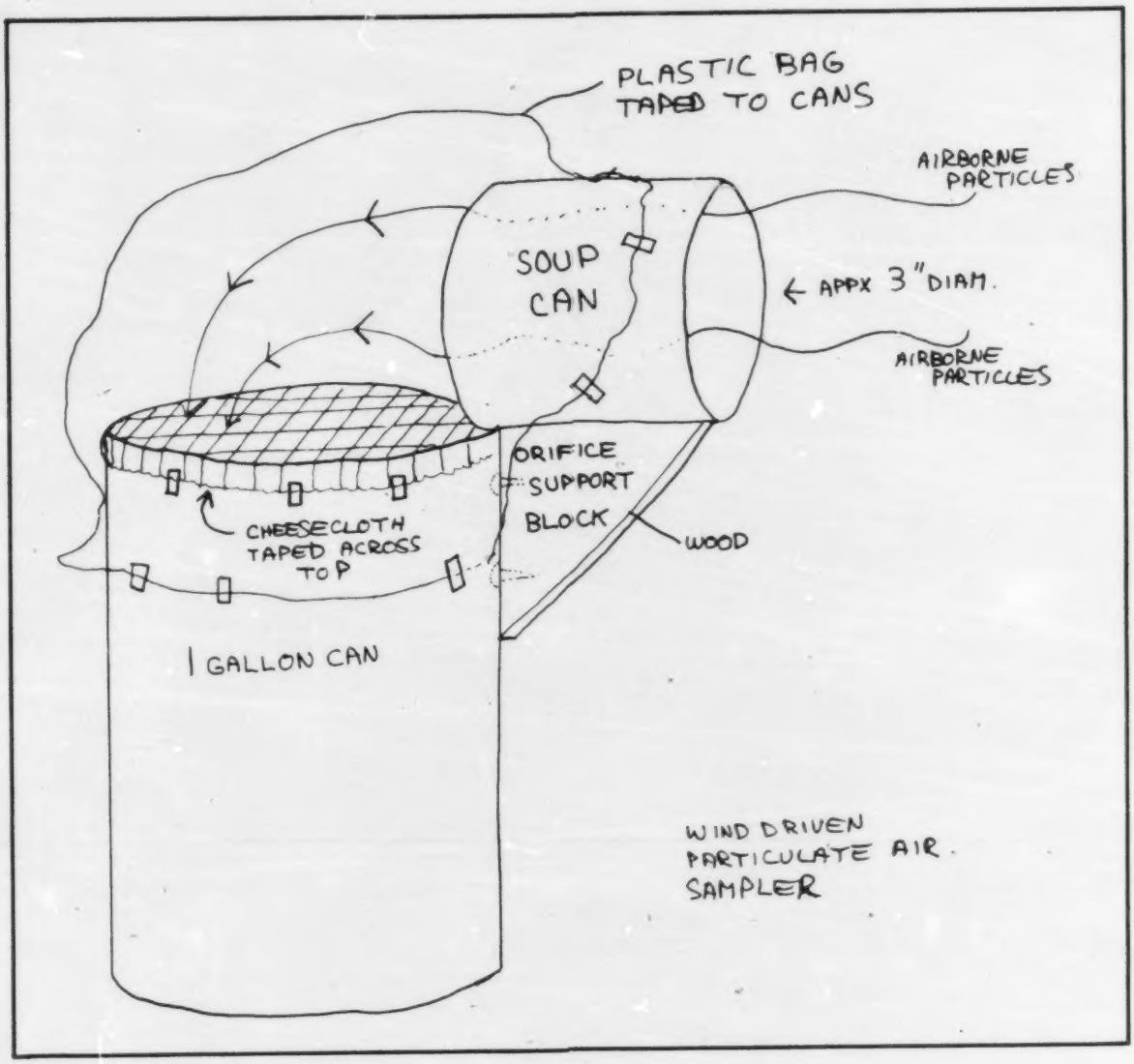
This wind driven air filter can be used to determine particulate content of the air over a set period.

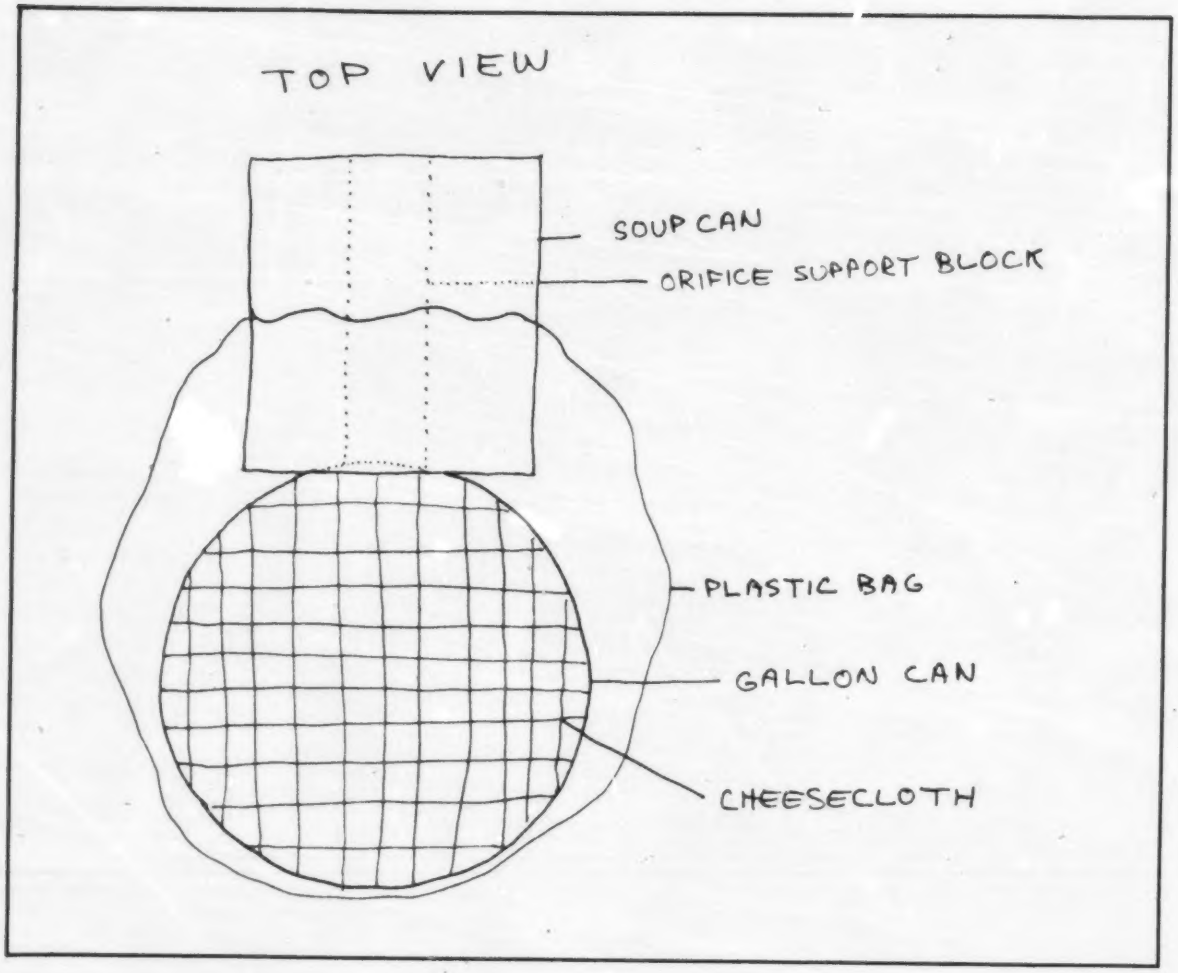
Using a 1 gallon can along with a soup can, screw or nail a triangular orifice support block to the large can, flush with the top. Position the small can on top of the block, adjacent to the large can, and epoxy it into place.

Cover the large can with a clean piece of cheesecloth and tape it down. Cover the top of the filter with a slit plastic bag, making sure the soup can (orifice) has a free air flow to the cheesecloth.

Place the sampler outside with the orifice facing into the wind. Airborne particles will be blown on to the cheesecloth and captured.

Examine the particles with a bio-scope and measure with an occular micrometer. Chemical analysis may be performed by washing the cheesecloth in alcohol, evaporating the alcohol and plane-testing the residue.


PLASTIC BAG
TAPED TO CANS
AIRBORNE
PARTICLES
SOUP
CAN
← APPX 3" DIAM.
AIRBORNE
PARTICLES
ORIFICE
SUPPORT
BLOCK
WOOD
CHEESECLOTH
TAPED ACROSS
TOP
1 GALLON CAN
WIND DRIVEN
PARTICULATE AIR
SAMPLER


TOP VIEW
SOUP CAN
ORIFICE SUPPORT BLOCK
PLASTIC BAG
GALLON CAN
CHEESECLOTH

ENVIRONMENTAL STUDIES PROGRAM

The Manchester Public School students utilizing the entire community as their classroom, along with the student-made equipment in this guide, have been able to overcome financial problems confronting many schools and obtain a good comprehensive knowledge of environmental issues they must face now and in the future.

The ENVIRONMENTAL STUDIES PROGRAM activities may be summarized as follows:

I. *The City-wide Curriculum Development Program in Environmental Studies.* This includes formal ecology classes in some schools and interdisciplinary classes along with demonstration units in other classes.

II. *The West High School Demonstration Unit.* This is a group of Ecology I students who travel throughout the city, visiting other schools and civic organizations demonstrating how to use the equipment illustrated in this guide plus HACH and Millipore equipment.

III. *The Environmental Presentation Unit.* This is a group of high ability students from Ecology II class, or advanced ecology students. They put on a slideshow, movie or video-tape shows they have produced on pollution. This group has put on an average of 200 showings a year all over New England.

IV. *A Curriculum Guide to Environmental Studies.* Produced by Manchester teachers and others throughout New England, this guide offers a collection of outstanding curriculum developments by teachers and students in the field of Environmental Studies.

V. *The Teacher Training Unit.* This is a group of highly dedicated teachers who train other teachers throughout New England. This is done after school and on weekends.

The above activities have been supported in part by the U.S. Office of Education, Office of Environmental Education.